SOLAR DIRECT

Bringing renewable technology down to earth!

*** INSTALLATION AGREEMENT ***

Customer Billing Information		Job Installation Information [X] same as billing		
Name: Mr Cateno Mancuso		Name		
Address: 5200 SW 59 Avenue		Address		Sub-Division
City ST Zip: Miami, Florida 33155		City ST Zip		County Name
Phone - Hm: 305-321-4000	Phone - Wk	Phone - Hm	Phone - Wk	
Phone - Cell	Phone - Fax	Phone - Cell	Phone - Fax	
Email Address: varese@bellsouth.net		Email Address		

Solar Power Production System
Utility Grid Connected consisting of 9.66 Kw Package, model #GTSB8000JK230-42, to include:
42 PV Modules – Brand: JinKo Model #:JKM230
Inverter – Brand:SunnyBoy Model #:SB8000US
All Mounting and Installation Hardware

The panels are to be mounted on the single story south facing barrel tile type roof. Solar Direct will perform a site survey to determine location of the solar system and components required for engineering and permitting.

Special Provisions: Contact EnerBank 866-405-7600 / Contractor ID # 5569 / Promo Code 821199 – Obtain an approval number and relay to Solar Direct. This contract is contingent upon rebate and finance approval.

SYSTEM COST: $34,617.26
Terms (cash):
Rebate Processing Fee $100.00 non-refundable
Terms (12 Months "Same-as-Cash Program):
(Checks provided by EnerBank USA)
Engineering and Equipment Deposit [X] Check $17,308.63
Balance upon job completion by [X] Check $17,308.63

ESTIMATE OF QUALIFYING REBATES AND INCENTIVES
1) FPL Rebate: Paid to customer directly; $19,320.00
2) Federal Income Tax Credit: Owner must file Residential Energy Credit Form #5695 w/IRS; 30%
3) **Cash Back Reward** – Cash Back Reward worth $2,596.29. This promotional offer can be redeemed after the system installation; reward funds may be paid to yourself, a charity of your choice, or to anyone you wish; rewards will be paid within 90 days of redemption.

Sales Representative ______ Date 10/21/11

OWNER ACCEPTANCE – The prices, specifications and conditions within this agreement are satisfactory and are hereby accepted. Payment will be made as outlined above.

Cateno Mancuso ______ Date 10/26/11

Authorized Solar Direct Executive Approval ______ Date ______

Owners Initials CM Date 10/26/11

Solar Direct • 6935 15th St E • Ste 120 • Sarasota FL 34243 • P 800.333.9276 F 800.897.6527

*** INSTALLATION AGREEMENT ***

SPECIAL REBATE PROGRAM PROVISIONS: Non-refundable application assistance fee of $100.00 will be applied to the Engineering Deposit once the utility rebate is approved. Customer may elect to cancel contract if the utility rebate reservation is not approved; or elect to maintain contract until next reservation cycle.

GENERAL CONDITIONS: This proposal may be withdrawn if not accepted within 10 days. Signing this proposal, or the making of a deposit, initiates this contract and indicates the acceptance of terms and conditions by the owner. This Contract will not become final until approved by an Authorized Company Executive. This contract constitutes all the terms and conditions of this agreement; any alterations or deviations requested from the above specifications must be in writing, and will be executed at additional costs; no oral agreements or statements shall be binding. The final price may be adjusted based on the actual STC (Standard Test Conditions) and/or BTU Name-Plate Rated power of the total system after engineering analysis, not to exceed +/-5%, and billed at the same cost per unit as the contracted system.

PAYMENTS: Any contract amount and/or payment over $5,000 includes a cash discount; payments must be made by cash, money order, check or bank transfer; payments by credit card over $5,000 will incur a surcharge of 3%.

COMPLETION: [1]Completion shall be defined as installation of an operational system; rebate application, final permit and/or utility inspection are performed after completion and final payment.

REBATES AND INCENTIVES: Solar Direct agrees to submit the documentation required to obtain the state rebate. Solar Direct is not liable for any rebate or incentive eligibility, amounts, or payments, except to complete an installation which meets state and federal rebate qualifications. Additional rebates, credits or incentives may be available; Customers should consult with a qualified tax professional to ensure the proper realization of such benefits if & when applicable.

LICENSING: The installation of the above equipment is contracted by Solar Direct, Inc., a Factory Certified, Bonded, Insured and Licensed Certified Contractor: Solar #CVC56728, Electrical #EC13002053, Commercial Pool #CPC042916.

PERMITTING: A standard permit fee, when required, is included in the contract price [Residential Fees: up to $150 for Solar Electric PV, up to $50 for other technologies; Commercial Fees: up to $250 for all technologies]; any additional permit fees or other fees required by the governing jurisdiction or utility shall be billed to and paid by the owner. A Notice of Commencement (NOC) is required for contracts over $2500 in Florida and is supplied by Solar Direct; the owner is required by state law to sign and record the NOC with the Clerk of Circuit Court prior to job start.

MATERIALS & WORKMANSHIP: All work is to be completed in a professional manner according to standard practices and codes. All material is new (unless otherwise stated) and guaranteed to be as specified. Solar Direct reserves the right to substitute brands and models of like kind and quality.

INSURANCE: Solar Direct will maintain the following coverage during the execution of this project: Workman's Compensation Insurance $1,000,000; Commercial Automotive Insurance $300,000; Commercial General Liability Insurance - $1,000,000 per occurrence, $2,000,000 aggregate, $2,000,000 Products and Completed Operations [Completed Operations coverage extends beyond the completion date and expires at the statute of limitations as set by state law; it covers liabilities for accidents and/or damage arising out of work or operations completed by Solar Direct as defined in the policy]. Certificate of Insurance is available upon request.

WARRANTIES: Solar Direct warranties labor for one year from date of installation. Unless otherwise specifically stated, Solar Direct does not manufacture products represented for sale or installation. Products are warranted by the manufacturer of the product and not Solar Direct except as allowed by law; see manufacture component warranty for specific details). Warranties do not include acts of God, unless specifically defined.

PERFORMANCE: Solar Direct makes no claim as to the performance or usability of any product. Performance timelines due to acts of God, accidents, or delays beyond our control, shall not be the responsibility of Solar Direct.

DISPUTE RESOLUTION: Any disputes arising out of this agreement shall entitle the prevailing party to all court costs and attorney fees. Venue shall be Sarasota County, Florida. The owner agrees to Mediation or Arbitration in the case of disputes.

DELINQUENCY: All accounts are C.O.D. unless payment terms have been extended. Accounts past thirty days will be subject to a finance charge of 1½% per month plus service charge. In addition, a service charge of $50 will apply for each past due incident.

CANCELLATIONS: Cancellations not received within 72 hours by certified mail will be subject up to a 20% cancellation and/or restocking charge.

INDEMNITY: Each party agrees to be liable for it's actions - Solar Direct agrees to save, defend, indemnify, and hold harmless the Client from liabilities including death, bodily injury, or property damage resulting from, connected with, or as a direct result of the performance of this Contract by the Solar Direct; Client agrees to save, defend, indemnify, and hold harmless Solar Direct from liabilities including death, bodily injury, or property damage resulting from, connected with, or as a direct result of the actions of the client, guests and/or his employees and/or adverse conditions of the property, building and/or mechanical systems during the performance of Solar Direct's contract.

SHADING CONDITIONS: Shading from trees and/or other obstructions limit the direct sunshine on the solar system reducing its ability to absorb and transmit energy - solar panels require direct solar radiation from 9am until 5pm for south facing or flat roofs (10am to 6pm for west roofs, 8am to 4pm for east roofs) in order to function properly. The owner will at their expense pay for any costs associated with removing shading obstructions and/or adding additional solar panels to increase energy gain.

Owners Initials CK Date 10/26/11

2

MIAMI-DADE COUNTY

"Delivering Excellence Every Day"

Miami-Dade County
Building & Neighborhood
Compliance Department
High Velocity Hurricane Zone
Electronic Permit Application

Property Owner's Solar System Disclosure Form

Master Permit Number:

Process Number: C2012038864

Contractor's Name: SOLAR DIRECT - KIRK MAUST / JEFFREY VOSS

Job Address: 5200 SW 59TH AVENUE, MIAMI, FL 33155

"The installation of roof mounted photovoltaic or thermal solar support systems typically require roof system penetrations to allow attachment to the structure which may create additional long-term roof system maintenance requirements and/or jeopardize roof system manufacturer's warranties.
Roof mounted solar systems generally require removal and reinstallation of solar panels/arrays in order to perform routine roof system maintenance, repair, or replacement."

[illegible]er's signature in the designate space indicates that the above information has [illegible] to the property owner.

Owner's Name: CATENO MANCUSO

Owner's Signature: Cateno Mancuso

Date: 1/10/12

Contractor's Signature:

Date: 1/5/12

Miami Dade County Building Department
0000714723 - 2/16/2012 4:17:40 PM
GENERAL01-01252012.pdf

Examiner	Date Time Stamp	Disp.	Trade	Stamp Name
Steven Gilbert	1/27/2012 2:42:46 PM	A	ELEC	Approved
Jeanne Clarke	2/16/2012 3:36:28 PM	I	STRU	Reference Only

#4

My Home

MIAMI-DADE

miamidade.gov

Property Information Report

Summary Details:

Folio No.:	30-4024-000-0560
Property:	5200 SW 59 AVE
Mailing Address:	CATENO MANCUSO 5200 SW 59 AVE MIAMI FL 33155-6359

Property Information:

Primary Zone:	2300 ESTATE RESIDENTIAL
CLUC:	0001 RESIDENTIAL - SINGLE FAMILY
Beds/Baths:	3/3
Floors:	1
Living Units:	1
Adj Sq Footage:	3,009
Lot Size:	43,560 SQ FT
Year Built:	1952
Legal Description:	24 54 40 1 AC N1/5 OF E1/2 OF NE1/4 OF SW1/4 OF SE1/4 LOT SIZE IRREGULAR OR 19037-1861 01 2000 4 OR 19037-1861 0100 01

Assessment Information:

Year:	2011	2010
Land Value:	$235,000	$251,000
Building Value:	$242,233	$242,363
Market Value:	$477,233	$493,363
Assessed Value:	$282,567	$278,392

Exemption Information:

Year:	2011	2010
Homestead:	$25,000	$25,000
2nd Homestead:	YES	YES

Taxable Value Information:

Year:	2011	2010
Taxing Authority:	Applied Exemption/ Taxable Value:	Applied Exemption/ Taxable Value:
Regional:	$50,000/$232,567	$50,000/$228,392
County:	$50,000/$232,567	$50,000/$228,392
City:	$0/$0	$0/$0
School Board:	$25,000/$257,567	$25,000/$253,392

Sale Information:

Sale Date:	1/2000
Sale Amount:	$0
Sale O/R:	19037-1861
Sales Qualification Description:	Sales which are disqualified as a result of examination of the deed
View Additional Sales	

[Close window] [Click here to Print]

Miami Dade County Building Department
0000714723 - 2/16/2012 4:17:40 PM
GENERAL01-01252012.pdf

This report was created on 11/3/2011 5:21:43 PM for reference purposes only.

Examiner	Date Time Stamp	Disp.	Trade	Stamp Name
Steven Gilbert	1/27/2012 2:42:46 PM	A	ELEC	Approved
Jeanne Clarke	2/16/2012 3:36:28 PM	I	STRU	Reference Only

5

SOLAR
D I R E C T

Bringing renewable technology down to earth!

January 17, 2012

Miami-Dade County Building Department
Room 207
11805 SW 26th Street
Miami, FL 33175-2464
Phone: (786) 315-2000

Regarding: Process Number #C2012038864; "Plan Review Correction Report",

Find below responses to the line items from the report (attached) that require correction.

Electrical

1.) *Electric sheet needs to be signed and sealed by engineer.*

Response: Electrical sheet now has engineer's raised and sealed stamp of approval.

2.) *Plans need to be electronically signed and sealed*

Response – Plans are being submitted as originals with engineer's raised and sealed stamp of approval.

3.) Provide net metering on the plan

Response – This concern was cleared up by the plans reviewer and approved. No action was needed.

4.) Clarify breaker size on both sheet 5 and electric sheet, 30 or 40.

Response – Sheet 5 has been corrected to show a 30 amp breaker will be installed.

5.) Clarify that breaker in the panel is approved for back feeding. What does solar breaker mean?

Response – Breaker is shown and will comply with NEC 2011 – 705.12 (D) (5) which states that " Circuit breakers that are marked "line" and "load" have been evaluated only in the direction marked. Circuit breakers without "Line" and "Load" have been evaluated in both directions" Therefore, only circuit breakers that are not marked shall be used for the purpose of back feeding.

In addition, the electrical sheet has been revised and the ambiguous term "solar breaker" has be stricken and edited for clarity to state, "Breaker 240V, 30 amps – suitable for backfeed in accordance with NEC 705.12(D)(5)"

6.) Clarify wire size feeding panel breaker, #12 wire is not large enough for 30 or 40 amp breaker.

Response – Typographical error on sheet 5 was corrected and now matches the electrical sheet which shows #10 AWG THWN-2/THHN wire feeding 30 amp panel breaker.

Miami Dade County Building Department
0000714723 - 2/16/2012 4:17:40 PM
GENERAL01-01252012.pdf

Examiner	Date Time Stamp	Disp	Trade	Stamp Name
Steven Gilbert	1/27/2012 2:42:46 PM	A	ELEC	Approved
Jeanne Clarke	2/16/2012 3:36:28 PM	I	STRU	Reference Only

PAGE INTENTIALLY LEFT BLANK

Structural

1.) Please comply with state laws or departmental rules for electronic signing and sealing. Submittal of scanned copies of signed and sealed documents is not an accepted electronic submittal method.

Response – Original raised and sealed stamped plans and drawing are being provided with this submittal. Electronic copies were given for a digital backup and were not intended to be used in place of the original hard copies at the time of application.

2.) Design wind loads shall comply with 2007 FBC Section 1620.2 (146 mph) and 1620.3 (Exposure Category C).

Response – Designed to exceed the 146-C requirement. The design factors utilized remains at 150-C.

3.) Provide the wind uplift zone (per ASCE-7) of the roof, the solar system is to be installed & the wind uplift pressure for that zone.

Response – Though installed in roof Zone I (37.66 psf) and Zone II (54.23 psf) only, the entire system was designed to exceed this by using the wind pressures of roof Zone III (87.51 psf). These pressures are listed on the "Solar Systems Roof Permit Form" and on the blueprint in the upper left hand corner in the notation box titled, "Design Factors". The wind load documentation begins on page 3 of the plans review binder.

4.) Provide the perimeter width (per ASCE-7) of the roof and/or roof section, the solar system is to be installed.

Response – The blueprint has been revised to include this and it can also be found on the "Solar Systems Roof Permit Form". The roof perimeter is 7 feet.

5.) Provide documentation and/or verification the support framing meets both uplift and lateral forces (C&C loads).

Response – The wind load calculations for the project are calculated based on the manufacturer's (UniRac®) specification for their frame and hardware which include all rail, clamps, bolts, brackets and attachments. The maximum rail span (2 feet) indicated on page 6 of the plans review binder is generated by the manufacturer (UniRac®). It dictates the maximum rail span that can be used with the SolarMount rail. This is based upon the design criteria entered by the installer (Solar Direct). In this case Solar Direct set these parameters above 146-C required by the building department. These values can be found on page 5.

Included with this submission are the technical datasheets from UniRac® for the clamps, bolts, brackets and rail. The specific properties of these components are listed for each type with the allowable and design loads.

Sincerely,

David Reed Stevens
Professional Engineer
8380 Glenfinnan Circle
Fort Myers, FL 33912
(239) 671-9210

Certified: David R. Stevens, P.E. FL #34624
1/24/12

David R. Stevens P.E.
PE 34624
Stevens & Associates, LLC
Certificate Of Authorization
29748

PAGE INTENTIALLY LEFT BLANK

MIAMI-DADE COUNTY

"Delivering Excellence Every Day"

Miami-Dade County
Building & Neighborhood Compliance Department
High Velocity Hurricane Zone
Electronic Permit Application

SOLAR SYSTEMS ROOF PERMIT FORM

Master Permit No:

Process No: C2012038864

Contractor's Name: SOLAR DIRECT - KIRK MAUST / JEFFREY VOSS

Job Address: 5200 SW 59TH AVENUE, MIAMI, FL 33155

All roofing repairs shall be performed using approved repair methods and compatible materials.

» [IS THIS PRODUCT CERTIFIED BY THE FLORIDA SOLAR ENERGY CENTER®?] **(FSCE)**

○ **YES** ◉ **NO**

☐ **Provide FSEC System Certification Approval Form**

☐ New Roof (requires separate roof permit) ☐ Re-roof (requires separate roof permit)

☑ Existing Roof

Roof Slope: 5 /12" Roof Mean Height: 15 ft

Roof perimeter width per ASCE-7: 7 ft

Provide roof uplift pressures per the High Velocity Hurricane Zone Test Protocols:

☐ **RAS-127 (steep slope roofs) -- or --** ☐ **RAS-128 (low slope roofs)**

-- or -- Provide site specific wind uplift calculations per ASCE 7 by a Design Professional

Zone P(1) Field: 37.66 psf

Zone P(2) Perimeter: 54.23 psf

Zone P(3) Corners: 87.51 psf

Miami Dade County Building Department
0000714723 2/16/2012 4:17:40 PM
GENERAL01-01252012.pdf

Examiner	Date Time Stamp	Disp.	Trade	Stamp Name
Steven Gilbert	1/27/2012 2:42:46 PM	A	ELEC	Approved
Jeanne Clarke	2/16/2012 3:36:28 PM	I	STRU	Reference Only

BOURCR

9

Select the Roof Zone the Photovoltaic / Thermal Solar Modules are installed in:

- [x] Zone P(1) Field
- [x] Zone P(2) Perimeter

NOTE: PHOTOVOLTAIC / THERMAL SOLAR MODULES SHALL NOT BE INSTALLED IN ZONE (P3) CORNERS OF ANY ROOF OR ROOF SECTION

Photovoltaic Laminate Modules (PVL) Adhered directly to roof systems

1. PVL module Product Control Approval Number: N/A

PVL module manufacturer: N/A

PVL module model number: N/A

2. Product Control Approval Number: N/A for the roof assembly listing the photovoltaic laminate module

3. Maximum design pressure From the PVL module Product Control Approval: N/A psf

4. ☐ Provide a Class "A" Fire Directory listing that includes the PVL module as a tested component in the roofing assembly.

5. Roof Deck Type: N/A

☐ **Photovoltaic Laminate (PVL) Modules Adhered to Low Sloped Roof Systems**

Select Low Slope Roof Assembly Type:

- [ ] Modified Bitumen
- [ ] Mineral Surfaced Fiberglass Cap Sheet
- [ ] Single Ply Membrane

Single Membrane Type: N/A

☐ **Photovoltaic Laminate (PVL) Modules Adhered to Sloped Metal Roof Panels**

☐ Structural Metal Roof Panels ☐ Architectural Metal Roof Panels

10

Rack or Direct Mount Photovoltaic / Thermal Solar Modules

Note: Provide details and attachment requirements for rack or direct roof mounted photovoltaic / thermal solar modules by a design Professional.

Select Type of Rack or Direct Mount Photovoltaic / Thermal Solar Modules

- ☑ Rack mounted photovoltaic module
- ☐ Direct roof mounted photovoltaic module
- ☐ Rack mounted thermal solar water heater ☐ Direct roof mounted thermal solar water heater
- ☐ Rack mounted thermal solar water heater w/ photovoltaic (PV) powered pump
- ☐ Direct roof mounted thermal solar water heater w/ photovoltaic (PV) powered pump
- ☐ Solar Swimming Pool Water Heater

Select Roof System Rack or Direct Mount Flat-plate Photovoltaic Modules are mounted on:

- ☐ Low Slope
- ☐ Metal Panel/Shingles
- ☑ Mechanically Fastened Tile ☐ Mortar / Adhesive Set Tile
- ☐ Asphaltic Shingles ☐ Wood Shingles/Shakes
- ☐ Other Roof System:

Deck Type:

PLYWOOD OSB

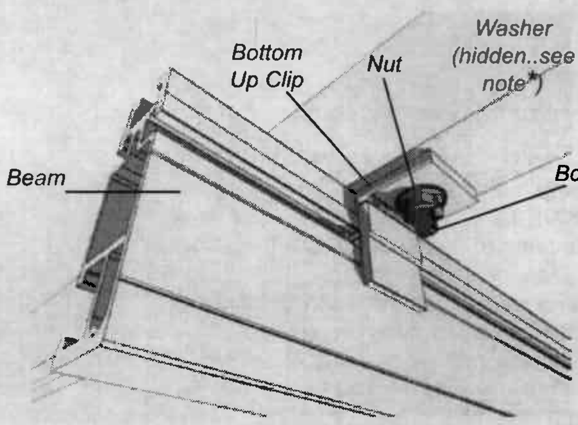
SolarMount Technical Datasheet

Pub 110818-1td V1.0 August 2011

SolarMount Module Connection Hardware

SolarMount Bottom Up Module Clip

Part No. 302000C



- **Bottom Up Clip material:** One of the following extruded aluminum alloys: 6005-T5, 6105-T5, 6061-T6
- **Ultimate tensile:** 38ksi, Yield: 35 ksi
- **Finish:** Clear Anodized
- **Bottom Up Clip weight:** ~0.031 lbs (14g)
- Allowable and design loads are valid when components are assembled with SolarMount series beams according to authorized UNIRAC documents
- Assemble with one ¼"-20 ASTM F593 bolt, one ¼"-20 ASTM F594 serrated flange nut, and one ¼" flat washer
- Use anti-seize and tighten to 10 ft-lbs of torque
- Resistance factors and safety factors are determined according to part 1 section 9 of the 2005 Aluminum Design Manual and third-party test results from an IAS accredited laboratory
- Module edge must be fully supported by the beam

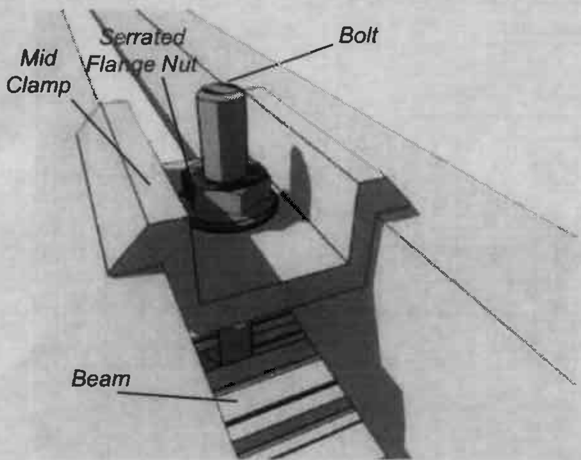
* **NOTE ON WASHER:** Install washer on bolt head side of assembly. **DO NOT** install washer under serrated flange nut

Applied Load Direction	Average Ultimate lbs (N)	Allowable Load lbs (N)	Safety Factor, FS	Design Load lbs (N)	Resistance Factor, Φ
Tension, Y+	1566 (6967)	686 (3052)	2.28	1038 (4615)	0.662
Transverse, X±	1128 (5019)	329 (1463)	3.43	497 (2213)	0.441
Sliding, Z±	66 (292)	27 (119)	2.44	41 (181)	0.619

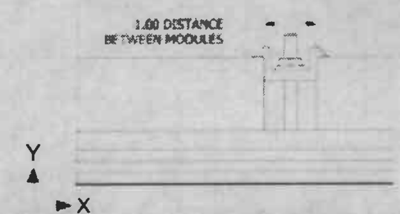
Dimensions specified in inches unless noted

SolarMount Mid Clamp

Part No. 302101C, 302101D, 302103C, 302104D, 302105D, 302106D



- **Mid clamp material:** One of the following extruded aluminum alloys: 6005-T5, 6105-T5, 6061-T6
- **Ultimate tensile:** 38ksi, Yield: 35 ksi
- **Finish:** Clear or Dark Anodized
- **Mid clamp weight:** 0.050 lbs (23g)
- Allowable and design loads are valid when components are assembled according to authorized UNIRAC documents
- Values represent the allowable and design load capacity of a single mid clamp assembly when used with a SolarMount series beam to retain a module in the direction indicated
- Assemble mid clamp with one Unirac ¼"-20 T-bolt and one ¼"-20 ASTM F594 serrated flange nut
- Use anti-seize and tighten to 10 ft-lbs of torque
- Resistance factors and safety factors are determined according to part 1 section 9 of the 2005 Aluminum Design Manual and third-party test results from an IAS accredited laboratory

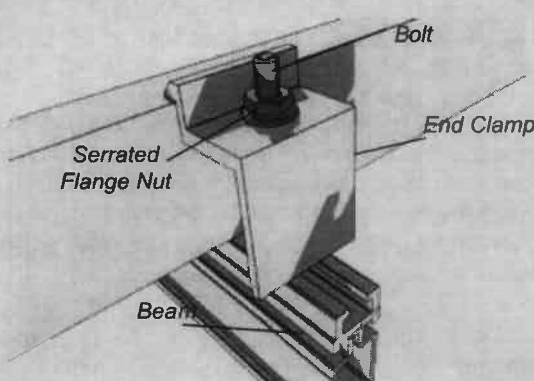


Dimensions specified in inches unless noted

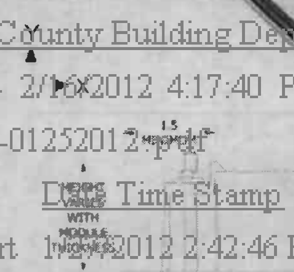
Applied Load Direction	Average Ultimate lbs (N)	Allowable Load lbs (N)	Safety Factor, FS	Design Load lbs (N)	Resistance Factor, Φ
Tension, Y+	2020 (8987)	891 (3963)	2.27	1348 (5994)	0.667
Transverse, Z±	520 (2313)	229 (1017)	2.27	346 (1539)	0.665
Sliding, X±	1194 (5312)	490 (2179)	2.44	741 (3295)	0.620

SolarMount End Clamp

Part No. 302001C, 302002C, 302002D, 302003C, 302003D, 302004C, 302004D, 302005C, 302005D, 302006C, 302006D, 302007D, 302008C, 302008D, 302009C, 302009D, 302010C, 302011C, 302012C



- **End clamp material:** One of the following extruded aluminum alloys: 6005-T5, 6105-T5, 6061-T6
- **Ultimate tensile:** 38ksi, Yield: 35 ksi
- **Finish:** Clear or Dark Anodized
- **End clamp weight:** varies based on height: ~0.058 lbs (26g)
- Allowable and design loads are valid when components are assembled according to authorized UNIRAC documents
- Values represent the allowable and design load capacity of a single end clamp assembly when used with a SolarMount series beam to retain a module in the direction indicated
- Assemble with one Unirac ¼"-20 T-bolt and one ¼"-20 ASTM F594 serrated flange nut
- Use anti-seize and tighten to 10 ft-lbs of torque
- Resistance factors and safety factors are determined according to part 1 section 9 of the 2005 Aluminum Design Manual and third-party test results from an IAS accredited laboratory
- Modules must be installed at least 1.5 in from either end of a beam



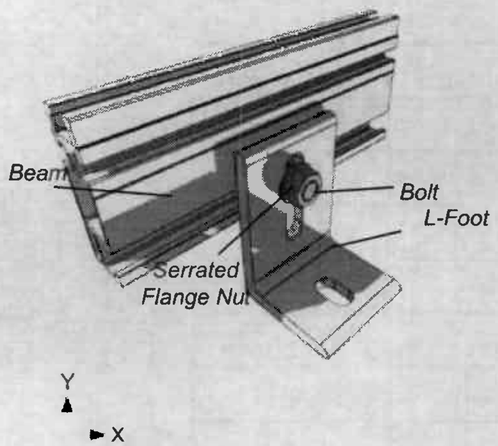
Dimensions specified in inches unless noted

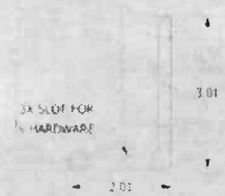
Applied Load Direction	Average Ultimate lbs (N)	Allowable Load lbs (N)	Safety Factor, FS	Design Loads lbs (N)	Resistance Factor, Φ
Tension, Y+	1321 (5876)	529 (2352)	2.50	800 (3557)	0.605
Transverse, Z±	63 (279)	14 (61)	4.58	21 (92)	0.330
Sliding, X±	142 (630)	52 (231)	2.72	79 (349)	0.555

SolarMount Beam Connection Hardware

SolarMount L-Foot

Part No. 304000C, 304000D





Dimensions specified in inches unless noted

- **L-Foot material:** One of the following extruded aluminum alloys: 6005-T5, 6105-T5, 6061-T6
- **Ultimate tensile:** 38ksi, Yield: 35 ksi
- **Finish:** Clear or Dark Anodized
- **L-Foot weight:** varies based on height: ~0.215 lbs (98g)
- Allowable and design loads are valid when components are assembled with SolarMount series beams according to authorized UNIRAC documents
- **For the beam to L-Foot connection:**
  - Assemble with one ASTM F593 ⅜"-16 hex head screw and one ASTM F594 ⅜"serrated flange nut
  - Use anti-seize and tighten to 30 ft-lbs of torque
- Resistance factors and safety factors are determined according to part 1 section 9 of the 2005 Aluminum Design Manual and third-party test results from an IAS accredited laboratory

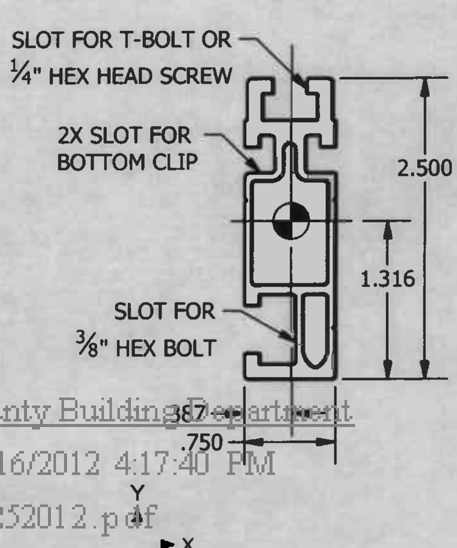
NOTE: Loads are given for the L-Foot to beam connection only; be sure to check load limits for standoff, lag screw, or other attachment method

Applied Load Direction	Average Ultimate lbs (N)	Allowable Load lbs (N)	Safety Factor, FS	Design Load lbs (N)	Resistance Factor, Φ
Sliding, Z±	1766 (7856)	755 (3356)	2.34	1141 (5077)	0.646
Tension, Y+	1859 (8269)	707 (3144)	2.63	1069 (4755)	0.575
Compression, Y-	3258 (14492)	1325 (5893)	2.46	2004 (8913)	0.615
Traverse, X±	486 (2162)	213 (949)	2.28	323 (1436)	0.664

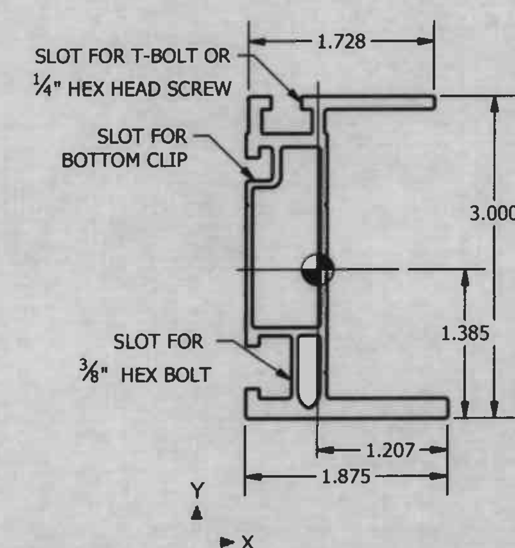
SolarMount Beams

Part No. 310132C, 310132C-B, 310168C, 310168C-B, 310168D
310208C, 310208C-B, 310240C, 310240C-B, 310240D,
410144M, 410168M, 410204M, 410240M

Properties	Units	SolarMount	SolarMount HD
Beam Height	in	2.5	3.0
Approximate Weight (per linear ft)	plf	0.811	1.271
Total Cross Sectional Area	in^2	0.676	1.059
Section Modulus (X-Axis)	in^3	0.353	0.898
Section Modulus (Y-Axis)	in^3	0.113	0.221
Moment of Inertia (X-Axis)	in^4	0.464	1.450
Moment of Inertia (Y-Axis)	in^4	0.044	0.267
Radius of Gyration (X-Axis)	in	0.289	1.170
Radius of Gyration (Y-Axis)	in	0.254	0.502



SolarMount Beam



SolarMount HD Beam

Dimensions specified in inches unless noted

15

SOLAR DIRECT

Bringing renewable technology down to earth!

December 29, 2011

Miami-Dade County
Building and Neighborhood Compliance Department
11805 SW 26th Street, Room 207
Miami, FL 33175

Re: Engineering Certification
Grid- Interactive Photovoltaic Solar Electric System

Plans Reviewer:

Attached are Engineering Documents, Specifications and Plans for permit package required for the installation of a Grid-Interactive Photovoltaic Solar Electric System.

Project Contact: Adam Diehl, 941-359-8228 Ext 101
Project Manager: Jason Tomczyk, 941-359-8228 Ext 192
Project Coordinator: Frank Heddings, 941-359-8228 Ext 199

Job Information:
Mancuso Residence
5200 SW 59th Ave
Miami, FL 33155

Design Firm:
Solar Direct, CAC29457
Kirk Maust, Senior Engineer
Adam Diehl, Industrial & Systems Engineer
6935 15th Street East, Suite 120
Sarasota FL 34243
941-359-8228

Engineer of Record:
Stevens & Associates, LLC
David Stevens, PE34624
8380 Glenfinnan Circle
Ft Myers FL 33912
239-671-9210

Contractor:
Solar Direct, CAC29457
Jeffrey Voss, EC13002053
Kirk Maust, CVC56728
6935 15th Street East, Suite 120
Sarasota FL 34243
941-359-8228

Examiner	Date Time Stamp	Disp.	Trade	Stamp Name
Steven Gilbert	1/27/2012 2:42:46 PM	A	ELEC	Approved
Jeanne Clarke	2/16/2012 3:36:28 PM	I	STRU	Reference Only

The procedure to determine Design Wind Load is specified by the American Society of Civil Engineers (ASCE) and referenced in the International Building Code (IBC) 2006. The appropriate wind speed has been determined by the local jurisdiction requirements. These are applied in accordance to the 2007 Florida Building Code (FBC) with 2008 and 2009 Supplements to determine the design level forces, which are based upon ASCE 7-02. For purposes of this design and the UniRac SolarMount™ "Code-Compliant Installation Manual 227" copyright February 2008, the values, equations and procedures used reference ASCE 7-05, Minimum Design Loads for Buildings and Other Structures, which matches the ASCE 7-02. The design is dependent upon conditions of spatial form, height and other structural parameters that are specified in the FBC provisions for determining the applied wind loading pressures imposed onto the UniRac SolarMount™ rails supporting the solar modules. The SolarMount™ railing and anchorage requirements for the installation are properly represented in the Installation manual 227.

Flush Mounted SolarMount™ applications on roofs or walls use Method 1, the Simplified Method, for calculating the Design Wind Load for pressures on components and cladding. Flush is defined as modules parallel to the surface with no more than 3" difference between the ends of the assembly and no more than 10" space between the roof surface and the bottom of the solar modules.

Tilt Mounted SolarMount™ applications (non-flush) on roofs use Method 2 for Open Buildings with a Monoslope Roof and are shown in UniRac Installation Supplements 206.1 for Low-Profile and 205.1 for High-Profile installations.

Electrical design elements are applied in accordance to the FBC and the National Electric Code (NEC) 2011.

The design verification is based on:

I. ASCE 7-02 and ASCE 7-05 – ASCE Standard
II. "Steel construction Manual", 13th Edition, American Institute of Steel Construction, Chicago IL, 2005
III. "Aluminum Design Manual", The Aluminum Association, Washington DC, 2005
IV. Mechanical Properties and Static Load Testing of UniRac extruded rails and related components obtained from Dr. Walter Gerstle, PE, Department of Civil Engineering, University of New Mexico, Albuquerque NM

By this letter, I certify that the UniRac SolarMount™ assembly, when installed in accordance with the Installation Manual 227, 205.1 and 206.1, and with the submittals and plans herein attached, will meet the requirements of the building codes adopted by Florida.

Florida Statutes governing Professional Engineers responsibilities for signatures of documents permits certification of the entire document by the signing and sealing of the cover page with a table of contents and binding the document. This page is for the purpose of certification of the following contents; all pages checked below have been reviewed and certified by the Engineer of Record:

n

Table of Contents (items checked are included): Page

Certified: David R. Stevens, P.E. FL #34624

1/24/12

David R. Stevens P.E.
PE 34624
Stevens & Associates, LLC
Certificate Of Authorization
29746

Page Intentionally Left Blank

Miami Dade County Building Department

0000714723 - 2/16/2012 4:17:40 PM

GENERAL01-01252012.pdf

Examiner	Date Time Stamp	Disp.	Trade	Stamp Name
Steven Gilbert	1/27/2012 2:42:46 PM	A	ELEC	Approved
Jeanne Clarke	2/16/2012 3:36:28 PM	I	STRU	Reference Only

SOLAR DIRECT

Bringing renewable technology down to earth!

November 12, 2011

Job:
Mancuso Residence
5200 SW 59th Ave
Miami, FL 33155

System Overview
Solar Electric System consisting of the following major components (see Typical Wiring Diagram):

Canadian Solar 42 @ 230W #ET-P660230 (9.66 kW)
UniRac SolarMount Mounting System
Grid-Interactive Control Center w/
SunnyBoy Inverter #SB8000US-11, NEMA6
Square-D AC Disconnect 240VAC, 60A, NEMA3R, Lockable Handle (or similar)

Description

The Solar PV Modules are roof mounted on the South facing roof section near to the utility meter and main distribution panel using UniRac's SolarMount (designed for 150 mph Wind Speed, Exposure Category C). This system consists of 3 series circuits of 14 modules (42 total).

Total System Power: 9.66 kW
Array#1 (9,660 Watts):
  Maximum Operating Voltage (DC): 573V
  Short-Circuit Current (DC): 23.5 Amps

Outdoor NEMA rated UV resistant #12AWG XLP USE-2 "MC" cables are used to connect 3 strings of 14 modules (42 modules total), which terminate in a Nema4x Wet Pull Junction Box (J-Box). The array wiring, #10AWG THWN-2/THHN, is routed via conduit to the inverter.

The inverter is fed by a 240VAC 30A circuit breaker in the main distribution panel (MDP) using #10AWG THHN wire. This system has an outdoor disconnect w/lockable handle to allow for disconnection from the grid power system for utility or emergency service.

All wiring and components are installed as per 2011 NEC Code.

#8AWG bare bonding wire is used for the equipment ground for Solar Array to the Junction Box. From the J-Box to the inverter and from the inverter to the MDP #8AWG THHN is used.MDP Bonding Wire to Ground Rod (existing).

19

Page Intentionally Left Blank

SOLAR DIRECT

Bringing renewable technology down to earth!

December 5, 2011
Project: Mancuso Residence – 9.66 kW – 42 ET Solar #ET-p660230 Modules
Address: 5200 SW 59th Avenue, Miami, FL 33155

Wind Load Calculations – Code Compliant Plan
(see supplements: IBC 2003 Wind Load – Components & Cladding, UniRac spacing Requirements)

1. Basic Wind Speed
   5200 SW 59th Avenue
   Miami, FL 33155
   Miami Dade County, 141 mph (Designed for 150 mph)

2. Exposure Category
   Exposure = C

3. Roof Zones
   Mounting within Zones I & II
   Entire system designed for Zone III

4. Wind Pressure (psf)
   Roof Height = 15 Ft max
   Basic psf = 87.51

5. Dead and Live Loads per Array
   42 Solar Modules: ET Solar #ET-P660230
   1 Array of 42 modules (Portrait)
   Size: 64.57" x 39.06"
   Weight: 41.9 lbs

Minimum Requirements (max spacing)	**Actual Design**
Portrait Arrays	Portrait Arrays
Required footing Spacing: 24" Max spacing	Foot Spacing: 24"
Live point load = 134.4 , -470.9 lbs	Live Point Load: 134.4 , -470.9 lbs

6. Required Pull-Out Limits
   Roof Truss Lumber: Southern Pine
   Min. Lag Screw: 5/16"x4" (3" Thread)
   Pull-Out Value per Inch Thread = 307 psf
   Design Pull-Out Value = 307 x 3 x 2 lags / footing = 1,842 psf

   Pull-Out Value 1,842 > 470.9 **OK**
   Safety Factor = 3.91

Page Intentionally Left Blank

SOLAR DIRECT Bringing renewable technology down to earth!

Solarmount / Sunframe Configurator Results

Project Specs

Name:	MANCUSO RESIDENCE
Email:	ADAM@SOLARDIRECT.COM
Telephone:	(941) 209-1439

Project Location

Address:	5200 SW 59TH AVE
City, State:	Miami, FL
Zip code:	33155
County:	Miami-Dade
Basic Wind Speed:	150 mph (User Modified)
Ground Snow Load:	0 psf

Array Information

Manufacturer:	ET Solar
Module Model:	ET-P660230
Module Size:	64.57" x 39.06"
Module Rows x Cols	3 x 14
Number of Arrays	1
Total Modules	42
Total Kilowatts	9.66
Racking Type	SolarMount Roofmount
Module Orientation	Portrait
Rail Direction	E-W

Engineering Variables

Description	Variable	Value	Units
Building Height	h	15	ft
Roof Angle		> 7 to 27	degrees
Wind Exposure		C	
Importance Factor		1	
Wind Speed	V	150	mph
Effective Wind Area		100	ft^2
Roof Zone		3	

Design Wind Load Calculation

Description	Variable	Value	Units
Net Design Wind Pressure (Uplift)	P_{net30} (Uplift)	-74.8	psf
Net Design Wind Pressure (Downforce)	P_{net30} (Downforce)	16.5	psf
Adjustment Factor for Height and Exposure Category	λ	1.21	
Importance Factor	I	1	
Design Wind Load (Uplift)	P_{net} (Uplift)	-90.51	psf
Design Wind Load (Downforce)	P_{net} (Downforce)	19.97	psf

Load Combinations Calculations

Description	Variable	Downforce	Uplift	Units
Dead Load	D	5	5	psf
Total Design Wind Load	Pnet	19.97	-90.51	psf
Snow Load	S	0		
Total Load Combination 1	D + 0.75Pnet + 0.75S	19.9775		psf

21

Total Load Combination 2	D + Pnet	24.97		psf
Total Load Combination 3	D + S	5		psf
Total Load Combination 4	0.6D + Pnet		-87.51	psf
Max Absolute Value Load		87.51		psf

Distributed Load Calculation

Description	Variable	Value	Units
Maximum Absolute Value of Load Combinations	P	87.51	psf
Module Length Perpendicular to Rails	B	5.38	ft
Distributed Load (Uplift)	w	-235.44	plf
Distributed Load (Downforce)	w	67.18	plf

Rail Span Information

Description	Variable	Value	Units
Racking Attachment Type		Single L	
Racking Attachment		L-Foot	
Rail preference			
Revised Rail Span	L	2	ft
Allowable Spans			
Single L Foot	SM	2	ft
Single L Foot	SMHD	3	ft
Double L Foot	SM	2	ft
Double L Foot	SMHD	3	ft

Point Load Calculations (per Code, these are based on maximum allowable spans as shown in chart above)

Description	Variable	Downforce	Uplift	Units
Single SM Point Load Force	R	134.4	-470.9	lbs
Single SMHD Point Load Force	R	201.5	-706.3	lbs

Point Load Calculations for your span are:

Rail preference				
Revised Rail Span	L		2	ft
Solar Mount Point Load Force	R	134.4	-470.9	lbs

This engineering report is to be evaluated to Unirac SolarMount Code Compliant Installation Manual 227 which references International Building Code 2003, International Building Code 2006, and ASCE 7-05, ASCE 7-02 and California Building Code 2010. The installation of products related to this engineering report is subject to requirements in the above mentioned installation manual.

22

SOLARMOUNT®

U.S. and other patents pending.

Lag Screw Specifications

Installation Supplement 203.2

Because lag bolt requirements vary with design wind load and the lumber used for the roof trusses, lag bolts are no longer provided with SolarMount rail sets.

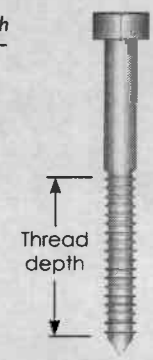
The table below (Table 4 from UniRac's Installation Manual 214: *SolarMount Code Compliant Planning and Assembly*) lists pull-out values for various roof truss lumber and the lag screws.

To ensure code compliance, the lag pull-out value must exceed the installation's design live load per footing multiplied by an appropriate safety factor. Use flat washers with lag screws.

For more information on design live loads, download Installation Manual 214 at www.unirac.com.

Lag pull-out (withdrawal) capacities (lbs) in typical roof truss lumber

	Specific gravity	*Lag screw specifications* 5/16" shaft,* 2½" thread depth	5/16" shaft,* per 1" thread depth	3/8" shaft,* per 1" thread depth
Douglas Fir, Larch	0.50	665	266	304
Douglas Fir, South	0.46	588	235	269
Engelmann Spruce, Lodgepole Pine (MSR 1650 f & higher)	0.46	588	235	269
Hem, Fir	0.43	530	212	243
Hem, Fir (North)	0.46	588	235	269
Southern Pine	0.55	768	307	352
Spruce, Pine, Fir	0.42	513	205	235
Spruce, Pine, Fir (E of 2 million psi and higher grades of MSR and MEL)	0.50	665	266	304



Sources: Uniform Building Code; American Wood Council.

Notes: (1) Thread must be embedded in a rafter or other structural roof member.
(2) Pull-out values incorporate a 1.6 safety factor recommended by the American Wood Council.
(3) See UBC for required edge distances.

**Use flat washers with lag screws.*

UniRac, Inc. www.unirac.com 1411 Broadway Boulevard NE Albuquerque NM 87102-1545 USA **505.242.6411** 505.242.6412 Fax

Pub 040812-1ii August 2004

UniRac welcomes input concerning the accuracy and user friendliness of this manual. Please write to **publications@unirac.com.**

Page Intentionally Left Blank

Miami Dade County Building Department

0000714723 - 2/16/2012 4:17:40 PM

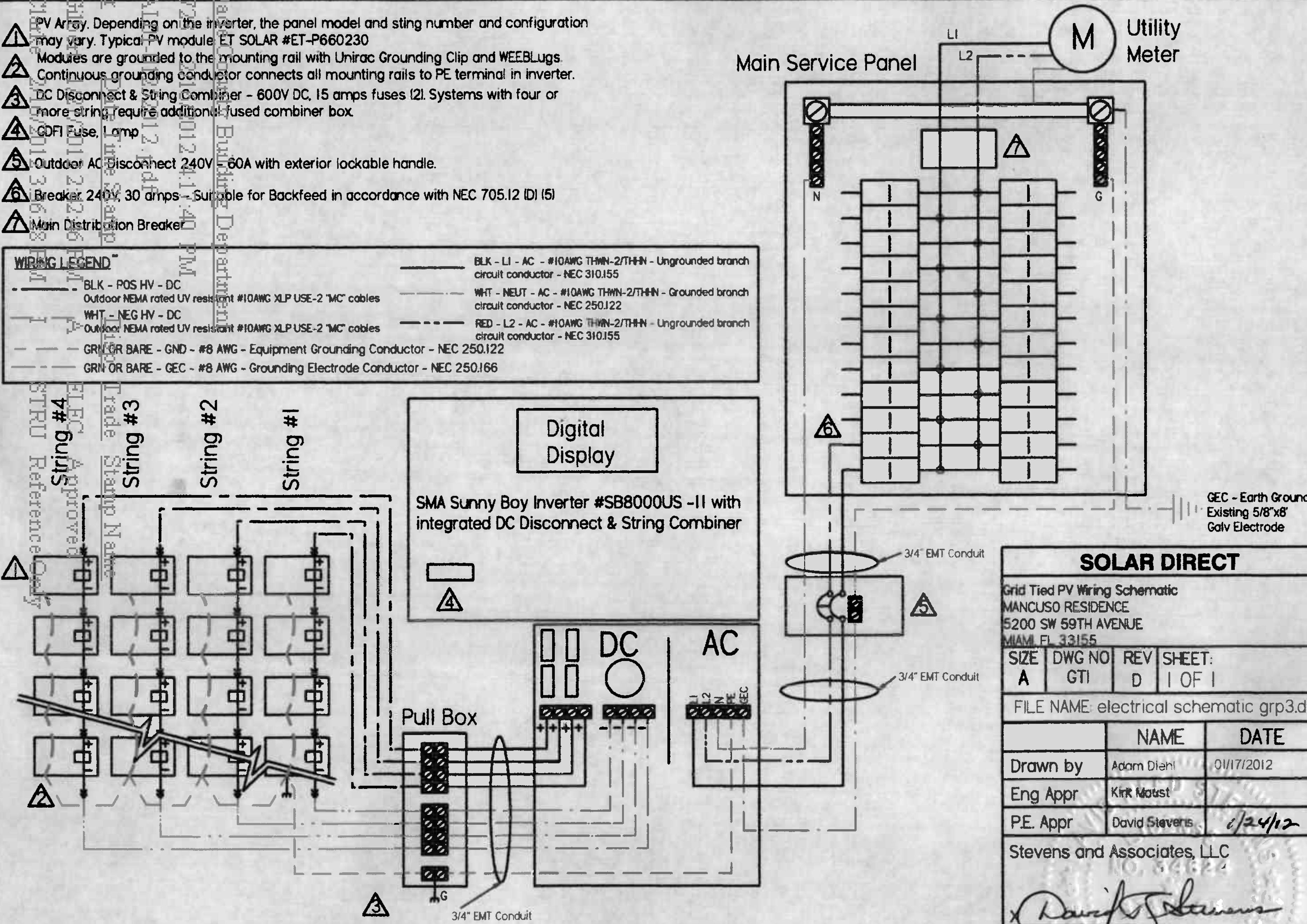
GENERAL01-01252012.pdf

Examiner	Date Time Stamp	Disp.	Trade	Stamp Name
Steven Gilbert	1/27/2012 2:42:46 PM	A	ELEC	Approved
Jeanne Clarke	2/16/2012 3:36:28 PM	I	STRU	Reference Only

1. PV Array. Depending on the inverter, the panel model and sting number and configuration may vary. Typical PV module ET SOLAR #ET-P660230
2. Modules are grounded to the mounting rail with Unirac Grounding Clip and WEEBLugs. Continuous grounding conductor connects all mounting rails to PE terminal in inverter.
3. DC Disconnect & String Combiner - 600V DC, 15 amps fuses (2). Systems with four or more string require additional fused combiner box.
4. GDFI Fuse, Lamp
5. Outdoor AC Disconnect 240V - 60A with exterior lockable handle.
6. Breaker 240V, 30 amps - Suitable for Backfeed in accordance with NEC 705.12 (D) (5)
7. Main Distribution Breaker

WIRING LEGEND

- BLK - POS HV - DC Outdoor NEMA rated UV resistant #10AWG XLP USE-2 "MC" cables
- WHT - NEG HV - DC Outdoor NEMA rated UV resistant #10AWG XLP USE-2 "MC" cables
- GRN OR BARE - GND - #8 AWG - Equipment Grounding Conductor - NEC 250.122
- GRN OR BARE - GEC - #8 AWG - Grounding Electrode Conductor - NEC 250.166
- BLK - L1 - AC - #10AWG THWN-2/THHN - Ungrounded branch circuit conductor - NEC 310.155
- WHT - NEUT - AC - #10AWG THWN-2/THHN - Grounded branch circuit conductor - NEC 250.122
- RED - L2 - AC - #10AWG THWN-2/THHN - Ungrounded branch circuit conductor - NEC 310.155



"All Wiring and components are installed as per NEC 2011

SOLAR DIRECT

Grid Tied PV Wiring Schematic
MANCUSO RESIDENCE
5200 SW 59TH AVENUE
MIAMI, FL 33155

SIZE	DWG NO	REV	SHEET:
A	GTI	D	1 OF 1

FILE NAME: electrical schematic grp3.dft

	NAME	DATE
Drawn by	Adam Diehl	01/17/2012
Eng Appr	Kirk Moust	
P.E. Appr	David Stevens	1/24/12

Stevens and Associates, LLC

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN FT-IN SCALE 1/4" = 1'0"

24

Solar Direct
6935 15th ST E
Sarasota FL 34243

Tel.: (800) 333-9276
Fax: (800) 897-6527
E-Mail: adam@solardirect.com
Internet: www.solardirect.com

Solar Direct • 6935 15th ST E • Sarasota FL 34243

MANCUSO RESIDENCE
52000 SW 59TH AVE
MIAMI, FL 33155

Project name: **MANCUSO RESIDENCE**
Project number: #51523
Project file:

Location: United States / Miami

Grid voltage: 1~240 V

System overview Part project 1

42 x ET Solar ET-P660230 (PV-array 1)
Azimuth angle: 0 °, Angle of inclination: 20 °, Mounting type: Roof, PV Peak power: 9.66 kW

Inverters:
1 x SB 8000US-11 - 240VAC (Inverter efficiency: 95.3 %)

Technical data

Total number of PV modules:	42	Energy usability factor:	100.0 %
PV Peak power:	9.66 kWp	Performance ratio (approx.)*:	81.7 %
Number of inverters:	1	Spec. energy yield (approx.)*:	1425 kWh/kWp
Nominal AC power:	7.68 kW	Line losses (in % of PV energy):	---
Annual energy yield (approx.)*:	13764.80 kWh	Unbalanced load:	7.68 kVA

Notes:

Version: 2.00.4.R

Miami Dade County Building Department
0000714723 - 2/16/2012 4:17:40 PM
GENERAL01-012...pdf

Signature

Important: The yield values displayed are estimates. They are determined mathematically. SMA Solar Technology AG accepts no responsibility for the real yield value which can deviate from the yield values displayed here. Reasons for deviations are various outside conditions, such as soiling of the PV Modules or fluctuations in the efficiency of the PV modules.

Examiner	Date Time Stamp	Disp.	Trade	Stamp Name
Steven Gilbert	1/27/2012 2:42:46 PM	A	ELEC	Approved
Jeanne Clarke	2/16/2012 3:36:28 PM	I	STRU	Reference Only

25

Evaluation of design

Project name: MANCUSO RESIDENCE
Project number: #51523
Project file:

Location: United States / Miami

Ambient temperature:
Record Low Temperature: 14.00 °F
Average High Temperature: 77.00 °F
Record High Temperature: 104.00 °F

Part project 1

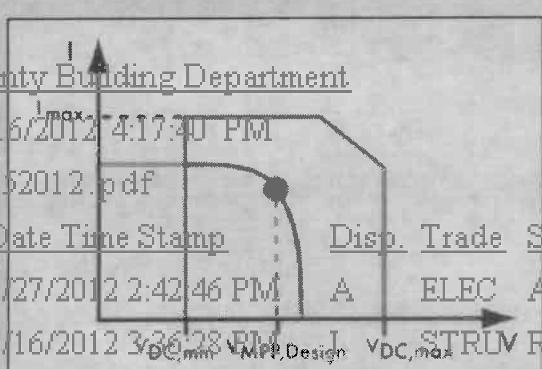
System overview

Inverter: 1 x SB 8000US-11 - 240VAC

PV-module:
A: (PV-array 1)
ET Solar
ET-P660230
Azimuth angle: 0 °, Angle of inclination: 20 °
Mounting type: Roof

Technical data

PV Peak power:	9.66 kWp
Total number of PV modules:	42
Number of inverters:	1
Max. DC power:	8.60 kW
Max. AC power:	7.68 kW
Grid voltage:	240 V
Nominal power ratio:	89.0 %
	Input A:
PV-array:	PV-array 1
Number of strings:	3
Number of PV modules (input):	14
Peak power (input):	9.66 kWp
Min. PV voltage:	332 V
Typical PV voltage:	369 V
Min. DC voltage (Grid voltage 240 V):	300 V
Max. PV voltage:	573 V
Max. DC voltage (Inverter):	600 V
Max. current of PV array:	23.5 A
Max. DC current:	30.0 A



PV/Inverter compatible
PV array and type of inverter are compatible. The nominal power ratio (max. DC power of the inverter divided by the peak power) is within the recommended range (80% - 120%).

Version 2.0.4.R

ru

SUNNY BOY 5000US / 6000US / 7000US / 8000US

- Highest CEC efficiency in its class
- Integrated load-break rated lockable DC disconnect switch
- Integrated fused series string combiner
- Sealed electronics enclosure & Opticool™
- Comprehensive SMA communications and data collection options
- Ideal for residential or commercial applications
- Sunny Tower compatible
- 10 year standard warranty
- UL 1741/IEEE-1547 compliant

SUNNY BOY 5000US/6000US/7000US / 8000US

The best in their class

Our US series inverters utilize our proven technology and are designed specifically to meet IEEE-1547 requirements. Sunny Boy 6000US, Sunny Boy 7000US and Sunny Boy 8000US are also compatible with the Sunny Tower. Increased efficiency means better performance and shorter payback periods. All four models are field-configurable for positive ground systems making them more versatile than ever. Throughout the world, Sunny Boy is the benchmark for PV inverter performance and reliability.

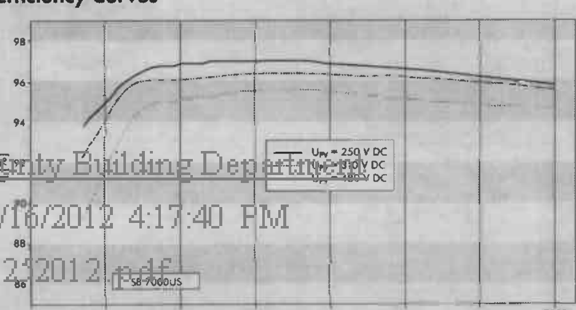
29

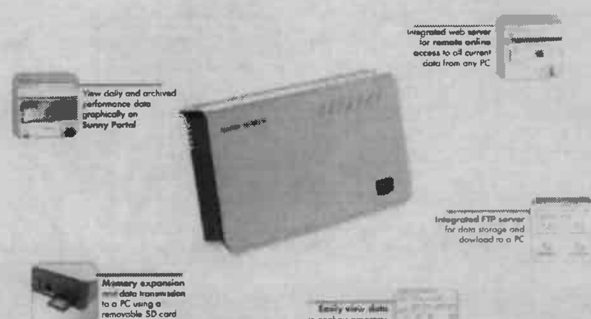
Technical Data

	SB 5000US	SB 6000US	SB 7000US	SB 8000US
Recommended Maximum PV Power (Module STC)	6250 W	7500 W	8750 W	10000 W
DC Maximum Voltage	600 V	600 V	600 V	600 V
Peak Power Tracking Voltage	250–480 V	250–480 V	250–480 V	300–480 V
DC Maximum Input Current	21 A	25 A	30 A	30 A
Number of Fused String Inputs	3 (inverter), 4 x 20 A (DC disconnect)	3 (inverter), 4 x 20 A (DC disconnect)	3 (inverter), 4 x 20 A (DC disconnect)	3 (inverter), 4 x 20 A (DC disconnect)
PV Start Voltage	300 V	300 V	300 V	365 V
AC Nominal Power	5000 W	6000 W	7000 W	8000 W
AC Maximum Output Power	5000 W	6000 W	7000 W	8000 W
AC Maximum Output Current (@ 208, 240, 277 V)	24 A, 21 A, 18 A	29 A, 25 A, 22 A	34 A, 29 A, 25 A	N/A, 32 A, 29 A
AC Nominal Voltage Range	183 - 229 V @ 208 V 211 - 264 V @ 240 V 244 - 305 V @ 277 V	183 - 229 V @ 208 V 211 - 264 V @ 240 V 244 - 305 V @ 277 V	183 - 229 V @ 208 V 211 - 264 V @ 240 V 244 - 305 V @ 277 V	N/A @ 208 V 211 - 264 V @ 240 V 244 - 305 V @ 277 V
AC Frequency: nominal / range	60 Hz / 59.3 - 60.5 Hz	60 Hz / 59.3 - 60.5 Hz	60 Hz / 59.3 - 60.5 Hz	60 Hz / 59.3 - 60.5 Hz
Power Factor (Nominal)	0.99	0.99	0.99	0.99
Peak Inverter Efficiency	96.8%	97.0%	97.1%	96.5%
CEC Weighted Efficiency	95.5% @ 208 V 95.5% @ 240 V 95.5% @ 277 V	95.5% @ 208 V 95.5% @ 240 V 96.0% @ 277 V	95.5% @ 208 V 96.0% @ 240 V 96.0% @ 277 V	N/A @ 208 V 96.0% @ 240 V 96.0% @ 277 V
Dimensions: W x H x D in inches	18.4 x 24.1 x 9.5	18.4 x 24.1 x 9.5	18.4 x 24.1 x 9.5	18.4 x 24.1 x 9.5
Weight / Shipping Weight	141 lbs / 148 lbs	141 lbs / 148 lbs	141 lbs / 148 lbs	148 lbs / 152 lbs
Ambient Temperature Range	−13 to 113 °F	−13 to 113 °F	−13 to 113 °F	−13 to 113 °F
Power consumption at night	0.1 W	0.1 W	0.1 W	0.1 W
Topology	Low frequency transformer, true sinewave	Low frequency transformer, true sinewave	Low frequency transformer, true sinewave	Low frequency transformer true sinewave
Cooling Concept	OptiCool™, forced active cooling	OptiCool™, forced active cooling	OptiCool™, forced active cooling	OptiCool™, forced active cooling
Mounting Location: indoor / outdoor (NEMA 3R)	●/●	●/●	●/●	●/●
LCD Display	●	●	●	●
Communication: RS485 / wireless	❍/❍	❍/❍	❍/❍	❍/❍
Warranty: 10 years / 15 years / 20 years	●/❍/❍	●/❍/❍	●/❍/❍	●/❍/❍
Compliance: IEEE-929, IEEE-1547, UL 1741, UL 1998, FCC Part 15 A & B	●	●	●	●
Specifications for nominal conditions		● Included	❍ Optional	

NOTE: US inverters ship with gray lids.

Efficiency Curves





Tel. +1 916 625 0870
Toll Free +1 888 4 SMA USA
www.SMA-America.com

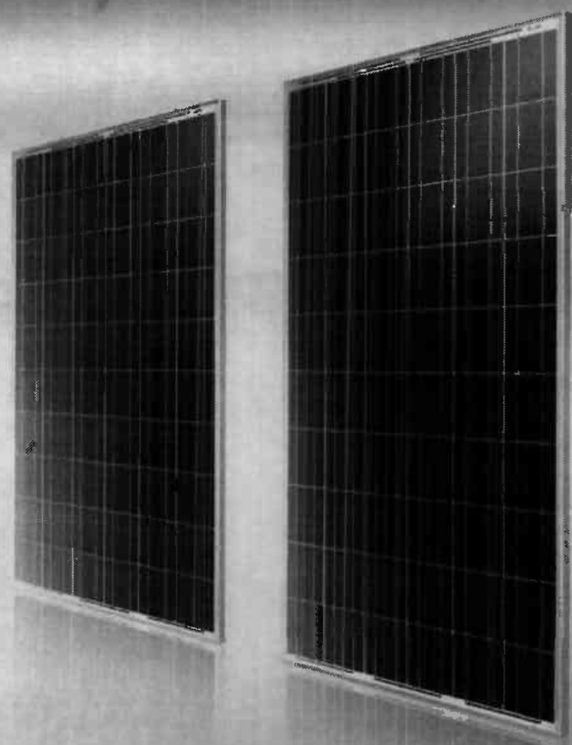
SMA America, LLC

28

ET MODULE

Polycrystalline

ET-P660250 250W
ET-P660245 245W
ET-P660240 240W
ET-P660235 235W
ET-P660230 230W
ET-P660225 225W

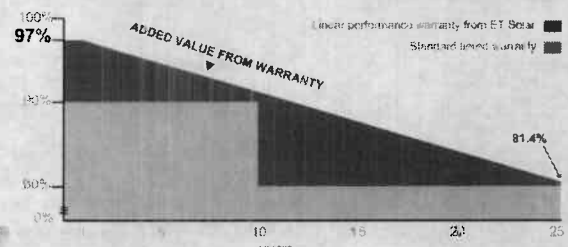


Features

- High module conversion efficiency, through superior manufacturing technology
- 0 to +5W positive tolerance for mainstream products
- Certified to withstand high wind loads and snow loads (5400Pa)
- Anodized aluminum is mainly for improving corrosion resistance
- Anti-reflective highly transparent, low iron tempered glass
- Excellent performance under low light environment

Benefits

- 25year linear performance warranty;
  10-year warranty on materials and workmanship
- Product liability insurance
- Local technical support
- Local warehousing
- 48 hour-response service
- Enhanced design for easy installation and long term reliability



Miami Dade County Building Department
0000714723 - 2/16/2012 4:17:40 PM
GENERAL01-01252012.pdf

Examiner	Date Time Stamp	Disp.	Trade	Stamp Name
Steven Gilbert	1/27/2012 2:4[illegible]46 PM	A	ELEC	Approved
Jeanne Clarke	2/16/2012 3:36:28 PM	I	STRU	Reference Only

IEC 61215 Ed.2
IEC 61730
BABT8510
PV CYCLE

Towards Excellence

ELECTRICAL SPECIFICATIONS

Model Type	ET-P660250	ET-P660245	ET-P660240	ET-P660235	ET-P660230	ET-P660225
Peak Power (Pmax)	250W	245W	240W	235W	230W	225W
Module Efficiency	15.37%	15.06%	14.75%	14.44%	14.14%	13.83%
Maximum Power Voltage (Vmp)	30.02V	29.40V	29.20V	29.08V	28.81V	28.35V
Maximum Power Current (Imp)	8.33A	8.32A	8.22A	8.08	8.00A	7.94A
Open Circuit Voltage (Voc)	37.58V	37.41V	37.25V	36.96V	36.88V	36.63V
Short Circuit Current (Isc)	8.98A	8.86A	8.78A	8.70A	8.60A	8.51A
Power Tolerance	±3%	0 to +5W	0 to +5W	0 to +5W	0 to +5W	0 to +5W
Maximum System Voltage	DC 1000V					
Normal Operating Cell Temperature	45.3±2℃					
Series Fuse Rating (A)	20A					
Number of Bypass Diode	3					

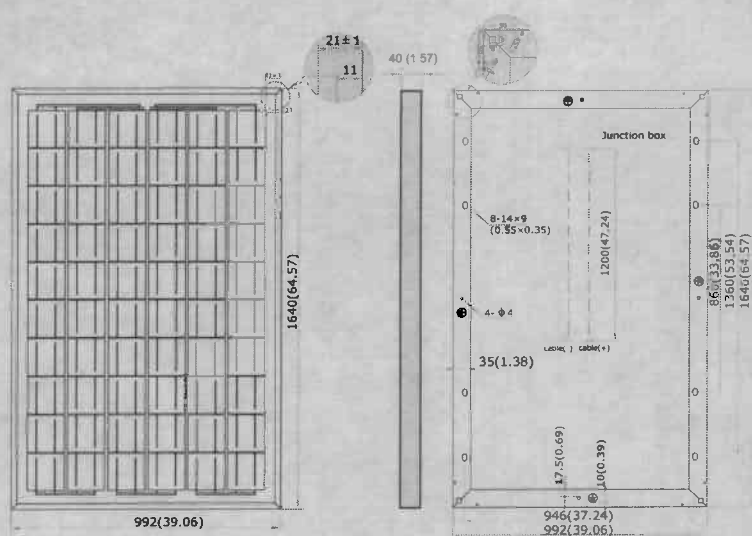
MECHANICAL SPECIFICATIONS

Cell type	156mm x 156mm
Number of cells	60 cells in series
Weight	19.32kg (42.59 lbs)
Dimensions	1640×992×40 mm (64.57×39.06×1.57 inch)
Max Load	5400Pascals (112 lb/ft²)

TEMPERATURE COEFFICIENT

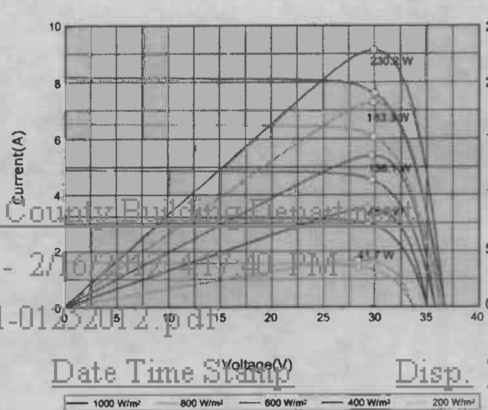
Temp. Coeff. of Isc (TK Isc)	0.065 %/℃
Temp. Coeff. of Voc (TK Voc)	-0.346 %/℃
Temp. Coeff. of Pmax (TK Pmax)	-0.46 %/℃

PHYSICAL CHARACTERISTICS Unit:mm (inch)

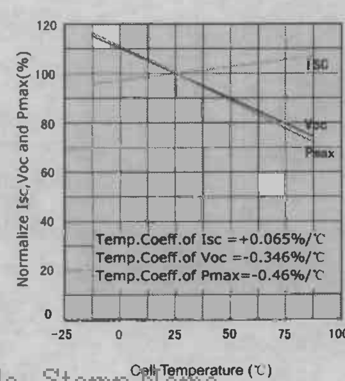


ELECTRICAL CHARACTERISTICS

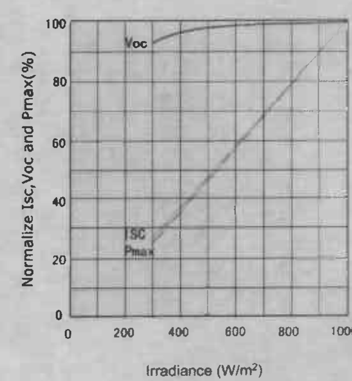
Electrical performance
(cell temperature:25℃)



Temperature dependence of Isc,
Voc and Pmax



Irradiance dependence of Isc,
Voc and Pmax (cell temperature:25℃)



Note: The specifications are [illegible]
The NOCT is obtained under the Test Conditions : 800 W/m², 20℃ ambient temperature, 1 m/s wind speed, AM 1.5 spectrum
Please contact **support@etsolar.com** for technical support. The parameters are for reference only, and are subject to change without notice or obligation.

30

SOLARMOUNT™

Code-Compliant Installation Manual 227

U.S. Des. Patent No. D496,248S, D496,249S. Other patents pending.

UniRac Code-Compliant Installation Manual

Table of Contents

UniRac® THE STANDARD IN PV MOUNTING STRUCTURES™

Pub 080118-2cc
February 2008

UniRac welcomes input concerning the accuracy and user-friendliness of this publication. Please write to publications@unirac.com.

3

i. Installer's Responsibilities

Please review this manual thoroughly before installing your SolarMount system.

This manual provides (1) supporting documentation for building permit applications relating to UniRac's SolarMount Universal PV Module Mounting system, and (2) planning and assembly instructions for SolarMount

SolarMount products, when installed in accordance with this bulletin, will be structurally adequate and will meet the structural requirements of the IBC 2006, IBC 2003, ASCE 7-02, ASCE 7-05 and California Building Code 2007 (collectively referred to as "the Code"). UniRac also provides a limited warranty on SolarMount products (page 26).

SolarMount is much more than a product.

It's a system of engineered components that can be assembled into a wide variety of PV mounting structures. With SolarMount you'll be able to solve virtually any PV module mounting challenge.

It's also a system of technical support: complete installation and code compliance documentation, an on-line SolarMount Estimator, person-to-person customer service, and design assistance to help you solve the toughest challenges.

Which is why SolarMount is PV's most widely used mounting system.

The installer is solely responsible for:

- Complying with all applicable local or national building codes, including any that may supersede this manual;
- Ensuring that UniRac and other products are appropriate for the particular installation and the installation environment;
- Ensuring that the roof, its rafters, connections, and other structural support members can support the array under all code level loading conditions (this total building assembly is referred to as the building structure);
- Using only UniRac parts and installer-supplied parts as specified by UniRac (substitution of parts may void the warranty and invalidate the letters of certification in all UniRac publications);
- Ensuring that lag screws have adequate pullout strength and shear capacities as installed;
- Verifying the strength of any alternate mounting used in lieu of the lag screws;
- Maintaining the waterproof integrity of the roof, including selection of appropriate flashing;
- Ensuring safe installation of all electrical aspects of the PV array; and
- Ensuring correct and appropriate design parameters are used in determining the design loading used for design of the specific installation. Parameters, such as snow loading, wind speed, exposure and topographic factor should be confirmed with the local building official or a licensed professional engineer.

32

Part I. Procedure to Determine the Design Wind Load

[1.1.] Using the Simplified Method - ASCE 7-05

The procedure to determine Design Wind Load is specified by the American Society of Civil Engineers and referenced in the International Building Code 2006. For purposes of this document, the values, equations and procedures used in this document reference ASCE 7-05, Minimum Design Loads for Buildings and Other Structures. ***Please refer to ASCE 7-05 if you have any questions about the definitions or procedures presented in this manual.*** UniRac uses Method 1, the Simplified Method, for calculating the Design Wind Load for pressures on components and cladding in this document.

The method described in this document is valid for flush, no tilt, SolarMount Series applications on either roofs or walls. Flush is defined as panels parallel to the surface (or with no more than 3" difference between ends of assembly) with no more than 10" space between the roof surface, and the bottom of the PV panels.

This method is not approved for open structure calculations. ***Applications of these procedures is subject to the following ASCE 7-05 limitations:***

1. The building height must be less than 60 feet, h < 60. See note for determining h in the next section. For installations on structures greater than 60 feet, contact your local UniRac Distributor.

2. The building must be enclosed, not an open or partially enclosed structure, for example a carport.

3. The building is regular shaped with no unusual geometrical irregularity in spatial form, for example a geodesic dome.

4. The building is not in an extreme geographic location such as a narrow canyon or steep cliff.

5. The building has a flat or gable roof with a pitch less than 45 degrees or a hip roof with a pitch less than 27 degrees.

6. If your installation does not conform to these requirements please contact your local UniRac distributor, a local professional engineer or UniRac

If your installation is outside the United States or does not meet all of these limitations, consult a local professional engineer or your local building authority. Consult ASCE 7-05 for more clarification on the use of Method I. Lower design wind loads may be obtained by applying Method II from ASCE 7-05. Consult with a licensed engineer if you want to use Method II procedures.

The equation for determining the Design Wind Load for components and cladding is:

$$p_{net}\,(psf) = \lambda K_{zt} I\, p_{net30}$$

p_{net} (psf) = Design Wind Load

λ = adjustment factor for height and exposure category

K_{zt} = Topographic Factor at mean roof height, h (ft)

I = Importance Factor

p_{net30} (psf) = net design wind pressure for Exposure B, at height = 30, I = 1

You will also need to know the following information:

Basic Wind Speed = V (mph), the largest 3 second gust of wind in the last 50 years.

h (ft) = total roof height for flat roof buildings or mean roof height for pitched roof buildings

Effective Wind Area (sf) = minimum total continuous area of modules being installed

Roof Zone = the area of the roof you are installing the pv system according to Figure 2, page 5.

Roof Zone Setback Length = a (ft)

Roof Pitch (degrees)

Exposure Category

[1.2.] Procedure to Calculate Total Design Wind

The procedure for determining the Design Wind Load can be broken into steps that include looking up several values in different tables.

Step 1: Determine *Basic Wind Speed, V (mph)*

Determine the *Basic Wind Speed, V (mph)* by consulting your local building department or locating your installation on the maps in Figure 1, page 4.

Step 2: Determining *Effective Wind Area*

Determine the smallest area of continuous modules you will be installing. This is the smallest area tributary (contributing load) to a support or to a simple-span of rail. That area is the Effective Wind Area.

33

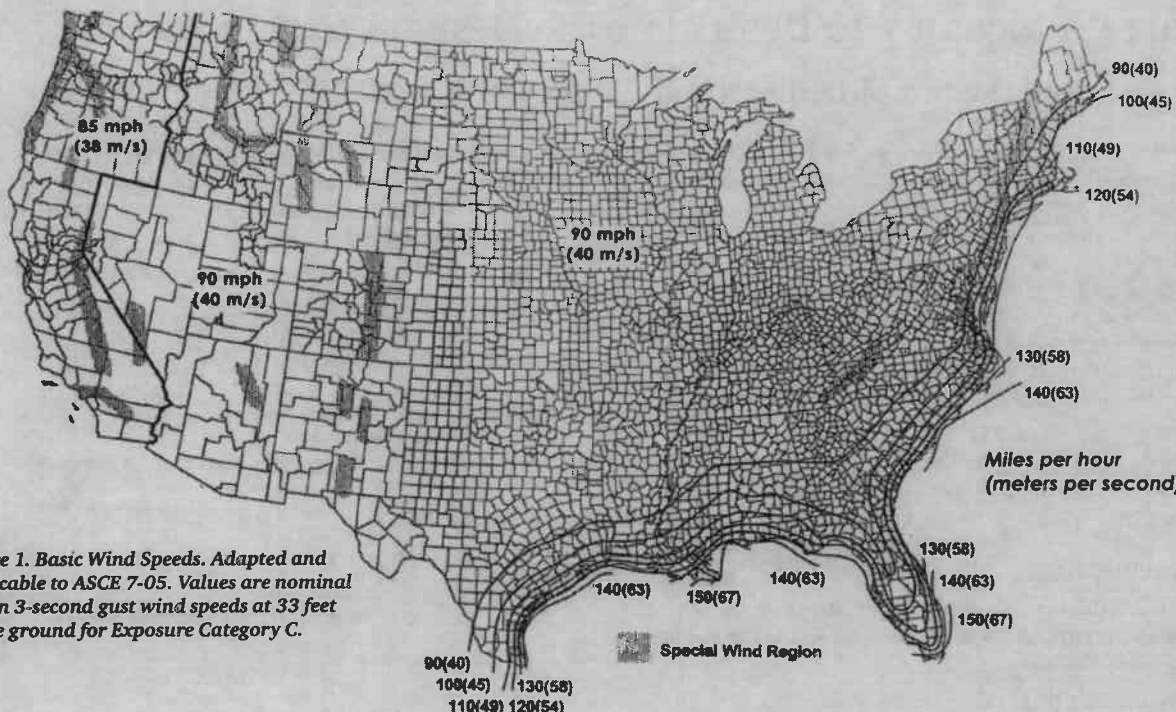


Figure 1. Basic Wind Speeds. Adapted and applicable to ASCE 7-05. Values are nominal design 3-second gust wind speeds at 33 feet above ground for Exposure Category C.

Step 3: Determine *Roof/Wall Zone*

The *Design Wind Load* will vary based on where the installation is located on a roof. Arrays may be located in more than one roof zone.

Using Table 1, determine the *Roof Zone Setback Length, a (ft)*, according to the width and height of the building on which you are installing the pv system.

Table 1. Determine Roof/Wall Zone, length (a) according to building width and height

a = 10 percent of the least horizontal dimension or 0.4h, whichever is smaller, but not less than either 4% of the least horizontal dimension or 3 ft of the building.

Roof Height (ft)	*Least Horizontal Dimension (ft)*																		
	10	*15*	*20*	*25*	*30*	*40*	*50*	*60*	*70*	*80*	*90*	*100*	*125*	*150*	*175*	*200*	*300*	*400*	*500*
10	3	3	3	3	3	4	4	4	4	4	4	4	5	6	7	8	12	16	20
15	3	3	3	3	3	4	5	6	6	6	6	6	6	6	7	8	12	16	20
20	3	3	3	3	3	4	5	6	7	8	8	8	8	8	8	8	12	16	20
25	3	3	3	3	3	4	5	6	7	8	9	10	10	10	10	10	12	16	20
30	3	3	3	3	3	4	5	6	7	8	9	10	12	12	12	12	12	16	20
35	3	3	3	3	3	4	5	6	7	8	9	10	12.5	14	14	14	14	16	20
40	3	3	3	3	3	4	5	6	7	8	9	10	12.5	15	16	16	16	16	20
45	3	3	3	3	3	4	5	6	7	8	9	10	12.5	15	17.5	18	18	18	20
50	3	3	3	3	3	4	5	6	7	8	9	10	12.5	15	17.5	20	20	20	20
60	3	3	3	3	3	4	5	6	7	8	9	10	12.5	15	17.5	20	24	24	24

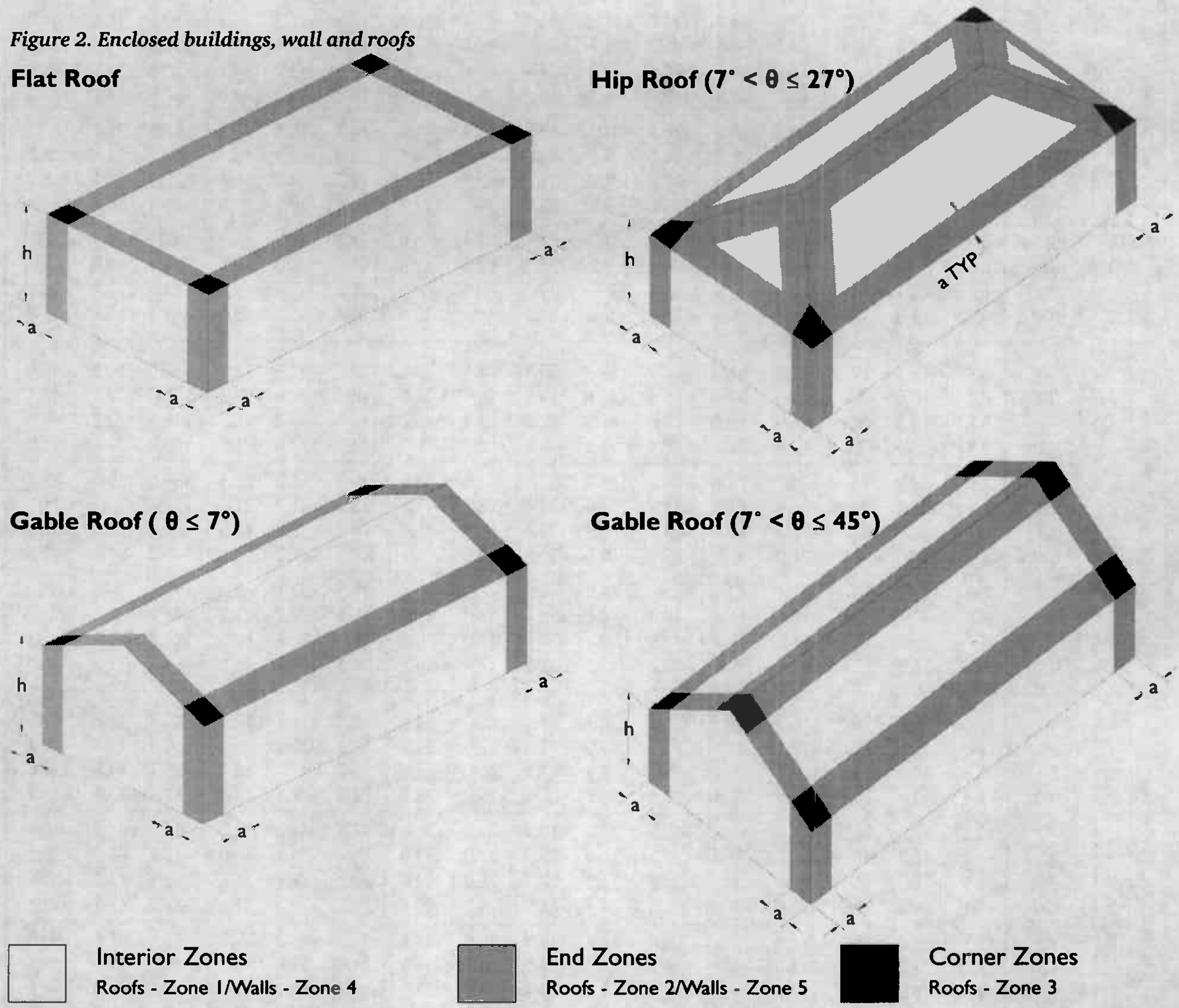
Source: ASCE/SEI 7-05, Minimum Design Loads for Buildings and Other Structures, Chapter 6, Figure 6-3, p. 41.

34

Step 3: Determine *Roof Zone* (continued)

Using *Roof Zone Setback Length*, a, determine the roof zone locations according to your roof type, gable, hip or monoslope. Determine in which roof zone your pv system is located, Zone 1, 2, or 3 according to Figure 2.

Figure 2. Enclosed buildings, wall and roofs



Source: *ASCE/SEI 7-05, Minimum Design Loads for Buildings and Other Structures, Chapter 6, p. 41.*

Step 4: Determine *Net Design Wind Pressure*, p_{net30} *(psf)*

Using the *Effective Wind Area* (Step 2), *Roof Zone Location* (Step 3), and *Basic Wind Speed* (Step 1), look up the appropriate *Net Design Wind Pressure* in Table 2, page 6. Use the *Effective Wind Area* value in the table which is smaller than the value calculated in Step 2. If the installation is located on a roof overhang, use Table 3, page 7.

Both downforce and uplift pressures must be considered in overall design. Refer to Section II, Step 1 for applying downforce and uplift pressures. Positive values are acting toward the surface. Negative values are acting away from the surface.

1~~3~~ 35

Table 2. p_{net30} (psf) Roof and Wall

			Basic Wind Speed (mph)															
			90		100		110		120		130		140		150		170	
	Zone	Effective Wind Area (sf)	Downforce	Uplift	Downforce	Uplift	Downforce	Uplift	Downforce	Uplift	Downforce	Uplift	Downforce	Uplift	Downforce	Uplift	Downforce	Uplift
Roof 0 to 7 degrees	1	10	5.9	-14.6	7.3	-18.0	8.9	-21.8	10.5	-25.9	12.4	-30.4	14.3	-35.3	16.5	-40.5	21.1	-52.0
	1	20	5.6	-14.2	6.9	-17.5	8.3	-21.2	9.9	-25.2	11.6	-29.6	13.4	-34.4	15.4	-39.4	19.8	-50.7
	1	50	5.1	-13.7	6.3	-16.9	7.6	-20.5	9.0	-24.4	10.6	-28.6	12.3	-33.2	14.1	-38.1	18.1	-48.9
	1	100	4.7	-13.3	5.8	-16.5	7.0	-19.9	8.3	-23.7	9.8	-27.8	11.4	-32.3	13.0	-37.0	16.7	-47.6
	2	10	5.9	-24.4	7.3	-30.2	8.9	-36.5	10.5	-43.5	12.4	-51.0	14.3	-59.2	16.5	-67.9	21.1	-87.2
	2	20	5.6	-21.8	6.9	-27.0	8.3	-32.6	9.9	-38.8	11.6	-45.6	13.4	-52.9	15.4	-60.7	19.8	78.0
	2	50	5.1	-18.4	6.3	-22.7	7.6	-27.5	9.0	-32.7	10.6	-38.4	12.3	-44.5	14.1	-51.1	18.1	-65.7
	2	100	4.7	-15.8	5.8	-19.5	7.0	-23.6	8.3	-28.1	9.8	-33.0	11.4	-38.2	13.0	-43.9	16.7	-56.4
	3	10	5.9	-36.8	7.3	-45.4	8.9	-55.0	10.5	-65.4	12.4	-76.8	14.3	-89.0	16.5	-102.2	21.1	-131.3
	3	20	5.6	-30.5	6.9	-37.6	8.3	-45.5	9.9	-54.2	11.6	-63.6	13.4	-73.8	15.4	-84.7	19.8	-108.7
	3	50	5.1	-22.1	6.3	-27.3	7.6	-33.1	9.0	-39.3	10.6	-46.2	12.3	-53.5	14.1	-61.5	18.1	-78.9
	3	100	4.7	-15.8	5.8	-19.5	7.0	-23.6	8.3	-28.1	9.8	-33.0	11.4	-38.2	13.0	-43.9	16.7	-56.4
Roof 7 to 27degrees	1	10	8.4	-13.3	10.4	-16.5	12.5	-19.9	14.9	-23.7	17.5	-27.8	20.3	-32.3	23.3	-37.0	30.0	-47.6
	1	20	7.7	-13.0	9.4	-16.0	11.4	-19.4	13.6	-23.0	16.0	-27.0	18.5	-31.4	21.3	-36.0	27.3	-46.3
	1	50	6.7	-12.5	8.2	-15.4	10.0	-18.6	11.9	-22.2	13.9	-26.0	16.1	-30.2	18.5	-34.6	23.8	-44.5
	1	100	5.9	-12.1	7.3	-14.9	8.9	-18.1	10.5	-21.5	12.4	-25.2	14.3	-29.3	16.5	-33.6	21.1	-43.2
	2	10	8.4	-23.2	10.4	-28.7	12.5	-34.7	14.9	-41.3	17.5	-48.4	20.3	-56.2	23.3	-64.5	30.0	-82.8
	2	20	7.7	-21.4	9.4	-26.4	11.4	-31.9	13.6	-38.0	16.0	-44.6	18.5	-51.7	21.3	-59.3	27.3	-76.2
	2	50	6.7	-18.9	8.2	-23.3	10.0	-28.2	11.9	-33.6	13.9	-39.4	16.1	-45.7	18.5	-52.5	23.8	-67.4
	2	100	5.9	-17.0	7.3	-21.0	8.9	-25.5	10.5	-30.3	12.4	-35.6	14.3	-41.2	16.5	-47.3	21.1	-60.8
	3	10	8.4	-34.3	10.4	-42.4	12.5	-51.3	14.9	-61.0	17.5	-71.6	20.3	-83.1	23.3	-95.4	30.0	-122.5
	3	20	7.7	-32.1	9.4	-39.6	11.4	-47.9	13.6	-57.1	16.0	-67.0	18.5	-77.7	21.3	-89.2	27.3	-114.5
	3	50	6.7	-29.1	8.2	-36.0	10.0	-43.5	11.9	-51.8	13.9	-60.8	16.1	-70.5	18.5	-81.0	23.8	-104.0
	3	100	5.9	-26.9	7.3	-33.2	8.9	-40.2	10.5	-47.9	12.4	-56.2	14.3	-65.1	16.5	-74.8	21.1	-96.0
Roof 27 to 45 degrees	1	10	13.3	-14.6	16.5	-18.0	19.9	-21.8	23.7	-25.9	27.8	-30.4	32.3	-35.3	37.0	-40.5	47.6	-52.0
	1	20	13.0	-13.8	16.0	-17.1	19.4	-20.7	23.0	-24.6	27.0	-28.9	31.4	-33.5	36.0	-38.4	46.3	-49.3
	1	50	12.5	-12.8	15.4	-15.9	18.6	-19.2	22.2	-22.8	26.0	-26.8	30.2	-31.1	34.6	-35.7	44.5	-45.8
	1	100	12.1	-12.1	14.9	-14.9	18.1	-18.1	21.5	-21.5	25.2	-25.2	29.3	-29.3	33.6	-33.6	43.2	-43.2
	2	10	13.3	-17.0	16.5	-21.0	19.9	-25.5	23.7	-30.3	27.8	-35.6	32.3	-41.2	37.0	-47.3	47.6	-60.8
	2	20	13.0	-16.3	16.0	-20.1	19.4	-24.3	23.0	-29.0	27.0	-34.0	31.4	-39.4	36.0	-45.3	46.3	-58.1
	2	50	12.5	-15.3	15.4	-18.9	18.6	-22.9	22.2	-27.2	26.0	-32.0	30.2	-37.1	34.6	-42.5	44.5	-54.6
	2	100	12.1	-14.6	14.9	-18.0	18.1	-21.8	21.5	-25.9	25.2	-30.4	29.3	-35.3	33.6	40.5	43.2	-52.0
	3	10	13.3	-17.0	16.5	-21.0	19.9	-25.5	23.7	-30.3	27.8	-35.6	32.3	-41.2	37.0	-47.3	47.6	-60.8
	3	20	13.0	-16.3	16.0	-20.1	19.4	-24.3	23.0	-29.0	27.0	-34.0	31.4	-39.4	36.0	-45.3	46.3	-58.1
	3	50	12.5	-15.3	15.4	-18.9	18.6	-22.9	22.2	-27.2	26.0	-32.0	30.2	-37.1	34.6	-42.5	44.5	-54.6
	3	100	12.1	-14.6	14.9	-18.0	18.1	-21.8	21.5	-25.9	25.2	-30.4	29.3	-35.3	33.6	-40.5	43.2	-52.0
Wall	4	10	14.6	-15.8	18.0	-19.5	21.8	-23.6	25.9	-28.1	30.4	-33.0	35.3	-38.2	40.5	-43.9	52.0	-56.4
	4	20	13.9	-15.1	17.2	-18.7	20.8	-22.6	24.7	-26.9	29.0	-31.6	33.7	-36.7	38.7	-42.1	49.6	-54.1
	4	50	13.0	-14.3	16.1	-17.6	19.5	-21.3	23.2	-25.4	27.2	-29.8	31.6	-34.6	36.2	-39.7	46.6	-51.0
	4	100	12.4	-13.6	15.3	-16.8	18.5	-20.4	22.0	-24.2	25.9	-28.4	30.0	-33.0	34.4	-37.8	44.2	-48.6
	4	500	10.9	-12.1	13.4	-14.9	16.2	-18.1	19.3	-21.5	22.7	-25.2	26.3	-29.3	30.2	-33.6	38.8	-43.2
	5	10	14.6	-19.5	18.0	-24.1	21.8	-29.1	25.9	-34.7	30.4	-40.7	35.3	-47.2	40.5	-54.2	52.0	-69.6
	5	20	13.9	-18.2	17.2	-22.5	20.8	-27.2	24.7	-32.4	29.0	-38.0	33.7	-44.0	38.7	-50.5	49.6	-64.9
	5	50	13.0	-16.5	16.1	-20.3	19.5	-24.6	23.2	-29.3	27.2	-34.3	31.6	-39.8	36.2	-45.7	46.6	-58.7
	5	100	12.4	-15.1	15.3	-18.7	18.5	-22.6	22.0	-26.9	25.9	-31.6	30.0	-36.7	34.4	-42.1	44.2	-54.1
	5	500	10.9	-12.1	13.4	-14.9	16.2	-18.1	19.3	-21.5	22.7	-25.2	26.3	-29.3	30.2	-33.6	38.8	-43.2

Source: ASCE/SEI 7-05, Minimum Design Loads for Buildings and Other Structures, Chapter 6, Figure 6-3, p. 42-43.

34

Table 3. p_{net30} (psf) Roof Overhang

	Zone	Effective Wind Area (sf)	Basic Wind Speed V (mph) 90	100	110	120	130	140	150	170
Roof 0 to 7 degrees	2	10	-21.0	-25.9	-31.4	-37.3	-43.8	-50.8	-58.3	-74.9
	2	20	-20.6	-25.5	-30.8	-36.7	-43.0	-49.9	-57.3	-73.6
	2	50	-20.1	-24.9	-30.1	-35.8	-42.0	-48.7	-55.9	-71.8
	2	100	-19.8	-24.4	-29.5	-35.1	-41.2	-47.8	-54.9	-70.5
	3	10	-34.6	-42.7	-51.6	-61.5	-72.1	-83.7	-96.0	-123.4
	3	20	-27.1	-33.5	-40.5	-48.3	-56.6	-65.7	-75.4	-96.8
	3	50	-17.3	-21.4	-25.9	-30.8	-36.1	-41.9	-48.1	-61.8
	3	100	-10.0	-12.2	-14.8	-17.6	-20.6	-23.9	-27.4	-35.2
Roof 7 to 27degrees	2	10	-27.2	-33.5	-40.6	-48.3	-56.7	-65.7	-75.5	-96.9
	2	20	-27.2	-33.5	-40.6	-48.3	-56.7	-65.7	-75.5	-96.9
	2	50	-27.2	-33.5	-40.6	-48.3	-56.7	-65.7	-75.5	-96.9
	2	100	-27.2	-33.5	-40.6	-48.3	-56.7	-65.7	-75.5	-96.9
	3	10	-45.7	-56.4	-68.3	-81.2	-95.3	-110.6	-126.9	-163.0
	3	20	-41.2	-50.9	-61.6	-73.3	-86.0	-99.8	-114.5	-147.1
	3	50	-35.3	-43.6	-52.8	-62.8	-73.7	-85.5	-98.1	-126.1
	3	100	-30.9	-38.1	-46.1	-54.9	-64.4	-74.7	-85.8	-110.1
Roof 27 to 45 degrees	2	10	-24.7	-30.5	-36.9	-43.9	-51.5	-59.8	-68.6	-88.1
	2	20	-24.0	-29.6	-35.8	-42.6	-50.0	-58.0	-66.5	-85.5
	2	50	-23.0	-28.4	-34.3	-40.8	-47.9	-55.6	-63.8	-82.0
	2	100	-22.2	-27.4	-33.2	-39.5	-46.4	-53.8	-61.7	-79.3
	3	10	-24.7	-30.5	-36.9	-43.9	-51.5	-59.8	-68.6	-88.1
	3	20	-24.0	-29.6	-35.8	-42.6	-50.0	-58.0	-66.5	-85.5
	3	50	-23.0	-28.4	-34.3	-40.8	-47.9	-55.6	-63.8	-82.0
	3	100	-22.2	-27.4	-33.2	-39.5	-46.4	-53.8	-61.7	-79.3

Source: ASCE/SEI 7-05, Minimum Design Loads for Buildings and Other Structures, Chapter 6, p. 44.

Step 5: Determine the Topographic Factor, K_{zt}

For the purposes of this code compliance document, the *Topographic Factor*, K_{zt}, is taken as equal to one (1), meaning, the installation is on level ground (less than 10% slope). If the installation is not on level ground, please consult ASCE 7-05, Section 6.5.7 and the local building authority to determine the *Topographic Factor*.

Step 6: Determine *Exposure Category (B, C, D)*

Determine the *Exposure Category* by using the following definitions for Exposure Categories.

The *ASCE/SEI 7-05** defines wind exposure categories as follows:

EXPOSURE B is urban and suburban areas, wooded areas, or other terrain with numerous closely spaced obstructions having the size of single family dwellings.

EXPOSURE C has open terrain with scattered obstructions having heights generally less than 30 feet. This category includes flat open country, grasslands, and all water surfaces in hurricane prone regions.

EXPOSURE D has flat, unobstructed areas and water surfaces outside hurrican prone regions. This category includes smooth mud flats, salt flats, and unbroken ice.

Also see ASCE 7-05 pages 287-291 for further explanation and explanatory photographs, and confirm your selection with the local building authority.

12 of 37

Step 7: Determine *adjustment factor for height and exposure category, λ*

Using the *Exposure Category* (Step 6) and the *roof height, h (ft)*, look up the *adjustment factor for height and exposure* in Table 4.

Step 8: Determine the *Importance Factor, I*

Determine if the installation is in a hurricane prone region. Look up the *Importance Factor, I*, Table 6, page 9, using the occupancy category description and the hurricane prone region status.

Step 9: Calculate the *Design Wind Load, p_{net} (psf)*

Multiply the *Net Design Wind Pressure, p_{net30}* (psf) (Step 4) by the *adjustment factor for height and exposure, λ* (Step 7), the *Topographic Factor, K_{zt}* (Step 5), and the *Importance Factor, I* (Step 8) using the following equation:

$$p_{net}\ (psf) = \lambda K_{zt} I\, p_{net30}$$

p_{net} *(psf) = Design Wind Load (10 psf minimum)*

λ = *adjustment factor for height and exposure category* (Step 7)

K_{zt} = *Topographic Factor at mean roof height, h (ft)* (Step 5)

I = *Importance Factor* (Step 8)

p_{net30} *(psf) = net design wind pressure for Exposure B, at height = 30, I = 1* (Step 4)

Use Table 5 below to calculate Design Wind Load.

The Design Wind Load will be used in **Part II** to select the appropriate SolarMount Series rail, rail span and foot spacing.

Table 4. Adjustment Factor for Roof Height & Exposure Category

Mean roof height (ft)	Exposure		
	B	C	D
15	1.00	1.21	1.47
20	1.00	1.29	1.55
25	1.00	1.35	1.61
30	1.00	1.40	1.66
35	1.05	1.45	1.70
40	1.09	1.49	1.74
45	1.12	1.53	1.78
50	1.16	1.56	1.81
55	1.19	1.59	1.84
60	1.22	1.62	1.87

Source: ASCE/SEI 7-05, Minimum Design Loads for Buildings and Other Structures, Chapter 6, Figure 6-3, p. 44.

Table 5. Worksheet for Components and Cladding Wind Load Calculation: IBC 2006, ASCE 7-05

Variable Description	Symbol	Value	Unit	Step	Reference
Building Height	h		ft		
Building, Least Horizontal Dimension			ft		
Roof Pitch			degrees		
Exposure Category				6	
Basic Wind Speed	V		mph	1	Figure 1
Effective Roof Area			sf		
				2	
Roof Zone Setback Length	a		ft	3	Table 1
Roof Zone Location				3	Figure 2
Net Design Wind Pressure	p_{net30}		psf	4	Table 2, 3
Topographic Factor	K_{zt}	x		5	
adjustment factor for height and exposure category	λ	x		7	Table 4
Importance Factor	I	x		8	Table 5
Total Design Wind Load	p_{net}		psf	9	

38

Table 6. Occupancy Category Importance Factor

Category	Category Description	Building Type Examples	Non-Hurricane Prone Regions and Hurricane Prone Regions with Basic Wind Speed, V = 85-100 mph, and Alaska	Hurricane Prone Regions with Basic Wind Speed, V > 100mph
I	Buildings and other structures that represent a low hazard to human life in the event of failure, including, but limited to:	Agricultural facilities Certain Temporary facilities Minor Storage facilities	0.87	0.77
II	All buildings and other structures except those listed in Occupancy Categories I, III, and IV.		I	I
III	Buildings and other structures that represent a substantial hazard to human life in the event of a failure, including, but not limited to:	Buildings where more than 300 people congregate Schools with a capacity more than 250 Day Cares with a capacity more than 150 Buildings for colleges with a capcity more than 500 Health Care facilities with a capacity more than 50 or more resident patients Jails and Detention Facilities Power Generating Stations Water and Sewage Treatment Facilities Telecommunication Centers Buildings that manufacutre or house hazardous materials	1.15	1.15
IV	Buildings and other structures designated as essential facilities, including, but not limited to:	Hospitals and other health care facilities having surgery or emergency treatment Fire, rescue, ambulance and police stations Designated earthquake, hurricane, or other emergency shelters Designated emergency preparednessm communication, and operation centers Power generating stations and other public utility facilities required in an emergency Ancillary structures required for operation of Occupancy Category IV structures Aviation control towers, air traffic control centers, and emergency aircraft hangars Water storage facilities and pump structures required to maintain water pressure for fire suppression Buildings and other structures having critical national defense functions	1.15	1.15

Source: IBC 2006, Table 1604.5, Occupancy Category of Buildings and other structures, p. 281; ASCE/SEI 7-05, Minimum Design Loads for Buildings and Other Structures, Table 6-1, p. 77

39

Part II. Procedure to Select Rail Span and Rail Type

[2.1.] Using Standard Beam Calculations, Structural Engineering Methodology

The procedure to determine the UniRac SolarMount series rail type and rail span uses standard beam calculations and structural engineering methodology. The beam calculations are based on a simply supported beam conservatively, ignoring the reductions allowed for supports of continuous beams over multiple supports. Please refer to **Part I** for more information on beam calculations, equations and assumptions.

In using this document, obtaining correct results is dependent upon the following:

1. Obtain the *Snow Load* for your area from your local building official.

2. Obtain the *Design Wind Load, p_{net}*. See **Part I** (Procedure to Determine the Design Wind Load) for more information on calculating the *Design Wind Load*.

3. *Please Note:* The terms rail span and footing spacing are interchangeable in this document. See Figure 3 for illustrations.

4. To use Table 8 and Table 9 the *Dead Load* for your specific installation must be less than 5 psf, including modules and UniRac racking systems. If the Dead Load is greater than 5 psf, see your UniRac distributor, a local structural engineer or contact UniRac.

The following procedure will guide you in selecting a UniRac rail for a flush mount installation. It will also help determine the design loading imposed by the UniRac PV Mounting Assembly that the building structure must be capable of supporting.

Step 1: Determine the *Total Design Load*

The *Total Design Load, P (psf)* is determined using ASCE 7-05 2.4.1 (ASD Method equations 3,5,6 and 7) by adding the *Snow Load*[1], S (psf), *Design Wind Load, p_{net} (psf)* from **Part I, Step 9** and the *Dead Load (psf)*. Both Uplift and Downforce Wind Loads calculated in Step 9 of Part 2 must be investigated. Use Table 7 to calculate the Total Design Load for the load cases. Use the maximum absolute value of the three downforce cases and the uplift case for sizing the rail. Use the uplift case only for sizing lag bolts pull out capacities (Part II, Step 6).

$P\ (psf) = 1.0D + 1.0S^1$ (downforce case 1)

$P\ (psf) = 1.0D + 1.0p_{net}$ (downforce case 2)

$P\ (psf) = 1.0D + 0.75S^1 + 0.75p_{net}$ (downforce case 3)

$P\ (psf) = 0.6D - 1.0p_{net}$ (uplift)

D = *Dead Load (psf)*

S = *Snow Load (psf)*

p_{net} = *Design Wind Load (psf)*

The maximum Dead Load, D (psf), is 5 psf based on market research and internal data.

[1] *Snow Load Reduction - The snow load can be reduced according to Chapter 7 of ASCE 7-05. The reduction is a function of the roof slope, Exposure Factor, Importance Factor and Thermal Factor. Please refer to Chapter 7 of ASCE 7-05 for more information.*

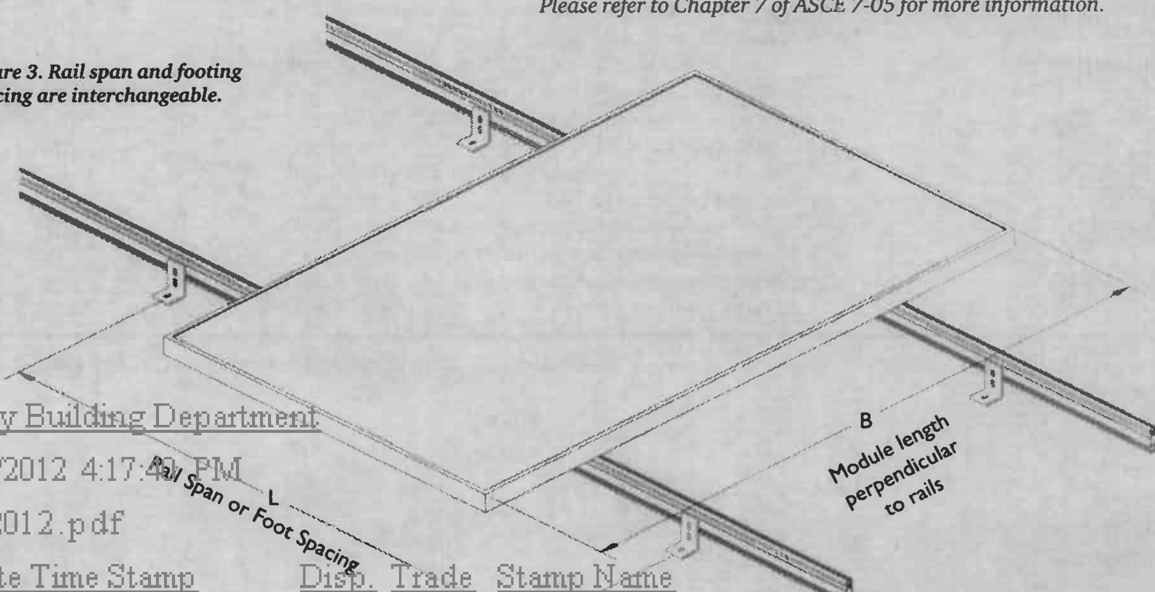


Figure 3. Rail span and footing spacing are interchangeable.

Note: Modules must be centered symmetrically on the rails (+/- 2*), as shown in Figure 3. If this is not the case, call UniRac for assistance.

20

Table 7. ASCE 7 ASD Load Combinations

Description	Variable	Downforce Case 1	Downforce Case 2	Downforce Case 3	Uplift	units
Dead Load	D	1.0 x	1.0 x	1.0 x	0.6 x	psf
Snow Load	S	1.0 x + ______		0.75 x + ______		psf
Design Wind Load	Pnet		1.0 x + ______	0.75 x + ______	1.0 x -	psf
Total Design Load	P					psf

Note: Table to be filled out or attached for evaluation.

Step 2: Determine the *Distributed Load on the rail, w (plf)*

Determine the *Distributed Load, w (plf)*, by multiplying the module width, B (ft), by the *Total Design Load, P (psf)* and dividing by two. Use the maximum absolute value of the three downforce cases and the Uplift Case. We assume each module is supported by two rails.

$$w = PB/2$$

w = Distributed Load (pounds per linear foot, plf)

B = Module Length Perpendicular to Rails (ft)

P = Total Design Pressure (pounds per square foot, psf)

Step 3: Determine *Rail Span/ L-Foot Spacing*

Using the *distributed load, w*, from Part II, **Step 2**, look up the *allowable spans, L*, for each UniRac rail type, SolarMount (SM) and SolarMount Heavy Duty (HD).

There are two tables, L-Foot SolarMount Series Rail Span Table and Double L-Foot SolarMount Series Rail Span Table. The L-Foot SolarMount Series Rail Span Table uses a single L-foot connection to the roof, wall or stand-off. The point load connection from the rail to the L-foot can be increased by using a double L-foot in the installation. Please refer to the **Part III** for more installation information.

Table 8. L-Foot SolarMount Series Rail Span

SM - SolarMount **HD - SolarMount Heavy Duty**

Span (ft)	w = Distributed Load (plf)																	
	20	25	30	40	50	60	80	100	120	140	160	180	200	220	240	260	280	300
2	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM
2.5	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM
3	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM		
3.5	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM				
4	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	HD						
4.5	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	HD							
5	SM	SM	SM	SM	SM	SM	SM	SM	HD	HD								
5.5	SM	SM	SM	SM	SM	SM	SM	HD	HD	HD								
6	SM	SM	SM	SM	SM	SM	HD	HD	HD									
6.5	SM	SM	SM	SM	SM	SM	HD	HD	HD									
7	SM	SM	SM	SM	SM	HD	HD	HD										
7.5	SM	SM	SM	SM	SM	HD	HD	HD										
8	SM	SM	SM	SM	HD	HD	HD											
8.5	SM	SM	SM	HD	HD	HD	HD											
9	SM	SM	SM	HD	HD	HD	HD											
9.5	SM	SM	SM	HD	HD	HD												
10	SM	SM	HD	HD	HD	HD												
10.5	SM	SM	HD	HD	HD	HD												
11	SM	HD	HD	HD	HD													
11.5	SM	HD	HD	HD	HD													
12	HD	HD	HD	HD														
12.5	HD	HD	HD	HD														
13	HD	HD	HD	HD														
13.5	HD	HD	HD															
14	HD	HD	HD															
14.5	HD	HD	HD															
15	HD	HD	HD															
15.5	HD	HD																
16	HD	HD																
17	HD																	

Table 9. Double L-Foot SolarMount Series Rail Span

SM - SolarMount **HD - SolarMount Heavy Duty**

Span (ft)	w = Distributed Load (plf)																	
	20	25	30	40	50	60	80	100	120	140	160	180	200	220	240	260	280	300
2	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM
2.5	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM
3	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM
3.5	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	HD	HD	HD	HD
4	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	HD	HD	HD	HD	HD	HD	
4.5	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	HD	HD	HD	HD	HD	HD		
5	SM	SM	SM	SM	SM	SM	SM	SM	HD	HD	HD	HD	HD	HD				
5.5	SM	SM	SM	SM	SM	SM	SM	HD	HD	HD	HD	HD	HD					
6	SM	SM	SM	SM	SM	SM	HD	HD	HD	HD	HD	HD						
6.5	SM	SM	SM	SM	SM	SM	HD	HD	HD	HD	HD							
7	SM	SM	SM	SM	SM	HD	HD	HD	HD	HD								
7.5	SM	SM	SM	SM	SM	HD	HD	HD	HD									
8	SM	SM	SM	SM	HD	HD	HD	HD										
8.5	SM	SM	SM	HD	HD	HD	HD											
9	SM	SM	SM	HD	HD	HD	HD											
9.5	SM	SM	SM	HD	HD	HD												
10	SM	SM	HD	HD	HD	HD												
10.5	SM	SM	HD	HD	HD	HD												
11	SM	HD	HD	HD	HD													
11.5	SM	HD	HD	HD	HD													
12	HD	HD	HD	HD														
12.5	HD	HD	HD	HD														
13	HD	HD	HD	HD														
13.5	HD	HD	HD															
14	HD	HD	HD															
14.5	HD	HD	HD															
15	HD	HD	HD															
15.5	HD	HD																
16	HD	HD																
17	HD																	

Step 4: Select Rail Type

Selecting a span and rail type affects the price of your installation. Longer spans produce fewer wall or roof penetrations. However, longer spans create higher point load forces on the building structure. A point load force is the amount of force transferred to the building structure at each connection.

It is the installer's responsibility to verify that the building structure is strong enough to support the point load forces.

Step 5: Determine the Downforce *Point Load, R (lbs)*, at each connection based on rail span

When designing the UniRac Flush Mount Installation, you must consider the downforce Point Load, R (lbs) on the roof structure.

The *Downforce, Point Load, R (lbs)*, is determined by multiplying the *Total Design Load, P (psf)* (Step 1) by the *Rail Span, L (ft)* (Step 3) and the *Module Length Perpendicular to the Rails, B (ft)* divided by two.

$$R\ (lbs) = PLB/2$$

R = Point Load (lbs)

P = Total Design Load (psf)

L = Rail Span (ft)

B = Module Length Perpendicular to Rails (ft)

It is the installer's responsibility to verify that the building structure is strong enough to support the maximum point loads calculated according to Step 5.

d2

Table 10. Downforce Point Load Calculation

Total Design Load (downforce) (max of case 1, 2 or 3)	P		psf	Step 1
Module length perpendicular to rails	B	x	ft	
Rail Span	L	x	ft	Step 4
		/2		
Downforce Point Load	R		lbs	

Step 6: Determine the Uplift Point Load, R (lbs), at each connection based on rail span

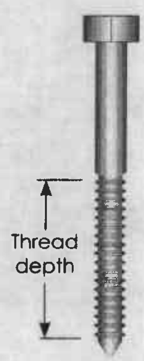
You must also consider the Uplift Point Load, R (lbs), to determine the required lag bolt attachment to the roof (building) structure.

Table 11. Uplift Point Load Calculation

Total Design Load (uplift)	P		psf	Step 1
Module length perpendicular to rails	B	x	ft	
Rail Span	L	x	ft	Step 4
		/2		
Uplift Point Load	R		lbs	

Table 12. Lag pull-out (withdrawal) capacities (lbs) in typical roof lumber (ASD)

		Lag screw specifications
	Specific gravity	*5/16″ shaft,* per inch thread depth*
Douglas Fir, Larch	**0.50**	**266**
Douglas Fir, South	**0.46**	**235**
Engelmann Spruce, Lodgepole Pine (MSR 1650 f & higher)	**0.46**	**235**
Hem, Fir, Redwood (close grain)	**0.43**	**212**
Hem, Fir (North)	**0.46**	**235**
Southern Pine	**0.55**	**307**
Spruce, Pine, Fir	**0.42**	**205**
Spruce, Pine, Fir (E of 2 million psi and higher grades of MSR and MEL)	**0.50**	**266**



Sources: American Wood Council, NDS 2005, Table 11.2A, 11.3.2A.

Notes: (1) Thread must be embedded in the side grain of a rafter or other structural member integral with the building structure.
(2) Lag bolts must be located in the middle third of the structural member.
(3) These values are not valid for wet service.
(4) This table does not include shear capacities. If necessary, contact a local engineer to specifiy lag bolt size with regard to shear forces.
(5) Install lag bolts with head and washer flush to surface (no gap). Do not over-torque.
(6) Withdrawal design values for lag screw connections shall be multiplied by applicable adjustment factors if necessary. See Table 10.3.1 in the American Wood Council NDS for Wood Construction.

**Use flat washers with lag screws.*

Use Table 12 to select a lag bolt size and embedment depth to satisfy your Uplift Point Load Force, R (lbs), requirements.

It is the installer's responsibility to verify that the substructure and attachment method is strong enough to support the maximum point loads calculated according to Step 5 and Step 6.

43

Part III. Installing SolarMount

The UniRac Code-Compliant Installation Instructions support applications for building permits for photovoltaic arrays using UniRac PV module mounting systems.

This manual, SolarMount Planning and Assembly, governs installations using the SolarMount and SolarMount HD (Heavy Duty) systems.

[3.1.] SolarMount® rail components

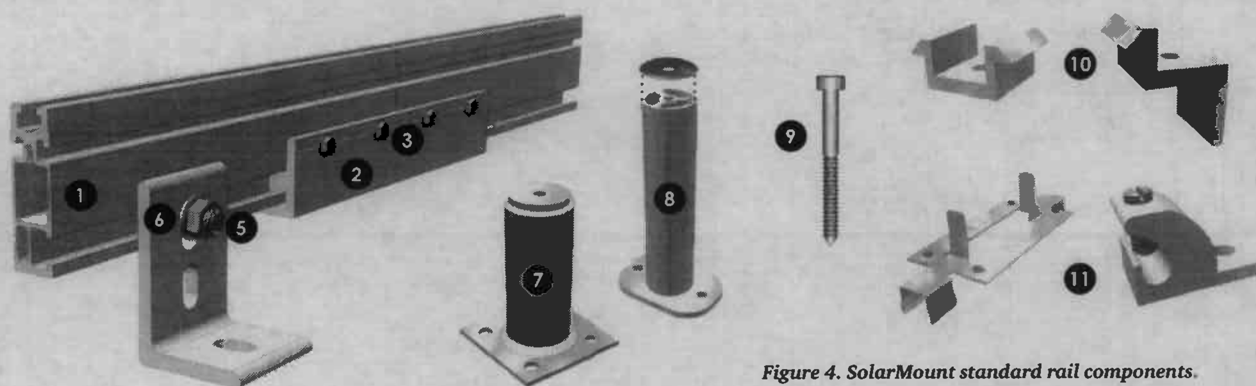


Figure 4. SolarMount standard rail components.

1. **Rail** – Supports PV modules. Use two per row of modules. 6105-T5 aluminum extrusion, anodized.

2. **Rail splice** – Joins and aligns rail sections into single length of rail. It can form either a rigid or thermal expansion joint, 8 inches long, predrilled. 6105-T5 aluminum extrusion, anodized.

3. **Self-drilling screw** – (No. 10 x ¾") – Use 4 per rigid splice or 2 per expansion joint. Galvanized steel.

4. **L-foot** – Use to secure rails either through roofing material to building structure or standoffs. Refer to loading tables for spacing. Note: Please contact UniRac for use and specification of double L-foot.

5. **L-foot bolt** (3/8" x ¾") – Use one per L-foot to secure rail to L-foot. 304 stainless steel.

6. **Flange nut** (3/8 ") – Use one per L-foot to secure rail to L-foot. 304 stainless steel.

7. **Flattop standoff** (optional) (3/8 ") – Use if L-foot bolt cannot be secured directly to rafter (with tile or shake roofs, for example). Sized to minimize roof to rail spacing. Use one per L-foot. One piece: Service Condition 4 (very severe) zinc-plated-welded steel. Includes 3/8 " x ¼" bolt with lock washer for attaching L-foot. Flashings: Use one per standoff. UniRac offers appropriate flashings for both standoff types.
Note: There is also a flange type standoff that does not require an L-foot.

8. **Aluminum two-peice standoff** (4" and 7") – Use one per L-foot. Two-piece: 6105-T5 aluminum extrusion. Includes 3/8" x 3/4" serrated flange bolt with EPDM washer for attaching L-foot, and two 5/16" lag bolts.

9. **Lag screw for L-foot** (5/16") – Attaches standoff to rafter.

10. **Top Mounting Clamps**

11. **Top Mounting Grounding Clips and Lugs**

Installer supplied materials:

- **Lag screw for L-foot** – Attaches L-foot or standoff to rafter. Determine the length and diameter based on pull-out values. If lag screw head is exposed to elements, use stainless steel. Under flashings, zinc plated hardware is adequate.

- **Waterproof roofing sealant** – Use a sealant appropriate to your roofing material. Consult with the company currently providing warranty of roofing.

24

[3.2.] Installing SolarMount with top mounting clamps

This section covers SolarMount rack assembly where the installer has elected to use top mounting clamps to secure modules to the rails. It details the procedure for flush mounting SolarMount systems to a pitched roof.

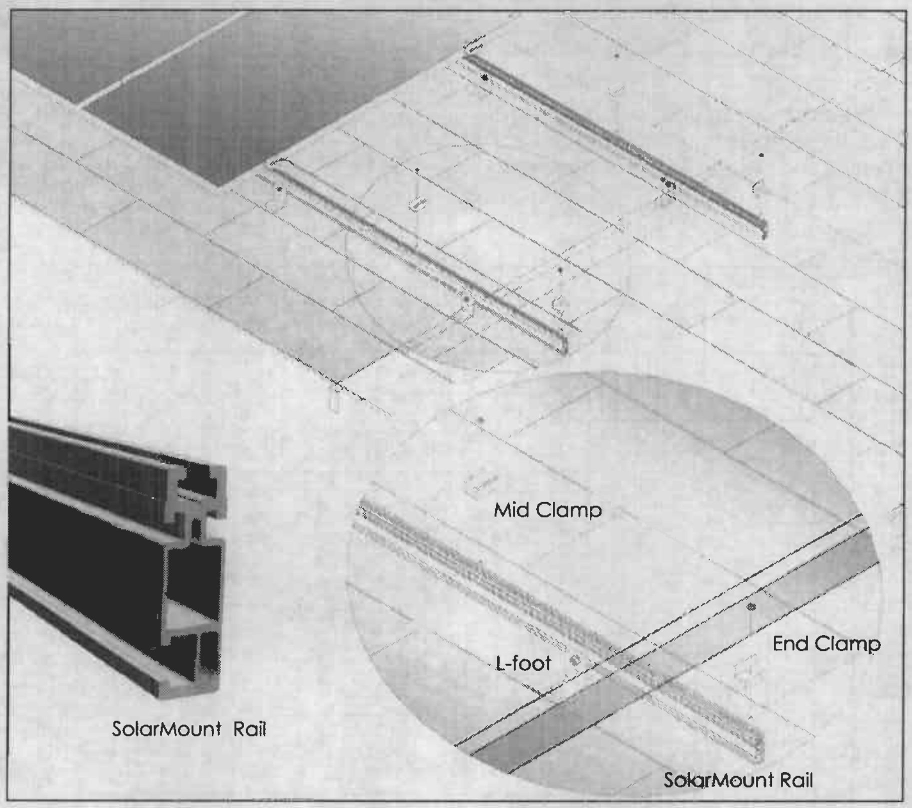


Figure 5. Exploded view of a flushmount installation mounted with L-feet.

Table 14. Clamp kit part quantities

Modules	End clamps	Mid clamps	¼″ module clamp bolts	¼″x ⅝″ safety bolts	¼″ flange nuts
2	4	2	6	2	8
3	4	4	8	2	10
4	4	6	10	2	12
5	4	8	12	2	14
6	4	10	14	2	16
7	4	12	16	2	18
8	4	14	18	2	20

Stainless steel hardware can seize up, a process called galling. To significantly reduce its likelihood, (1) apply lubricant to bolts, preferably an anti-seize lubricant, available at auto parts stores, (2) shade hardware prior to installation, and (3) avoid spinning on nuts at high speed. See Installation Supplement 910, Galling and Its Prevention, at www.unirac.com.

Table 15 Wrenches and torque

	Wrench size	Recommended torque (ft-lbs)
¼″ hardware	7⁄16″	15
⅜″ hardware	9⁄16″	30

Torques are not designated for use with wood connectors

FP 45

[3.2.1] Planning your SolarMount® installations

The installation can be laid out with rails parallel to the rafters or perpendicular to the rafters. Note that SolarMount rails make excellent straight edges for doing layouts.

Center the installation area over the structural members as much as possible.

Leave enough room to safely move around the array during installation. Some building codes require minimum clearances around such installations, and the user should be directed to also check 'The Code'.

The width of the installation area equals the length of one module.

The length of the installation area is equal to:

- the total width of the modules,
- plus 1 inch for each space between modules (for mid-clamp),
- plus 3 inches (1½ inches for each pair of end clamps).

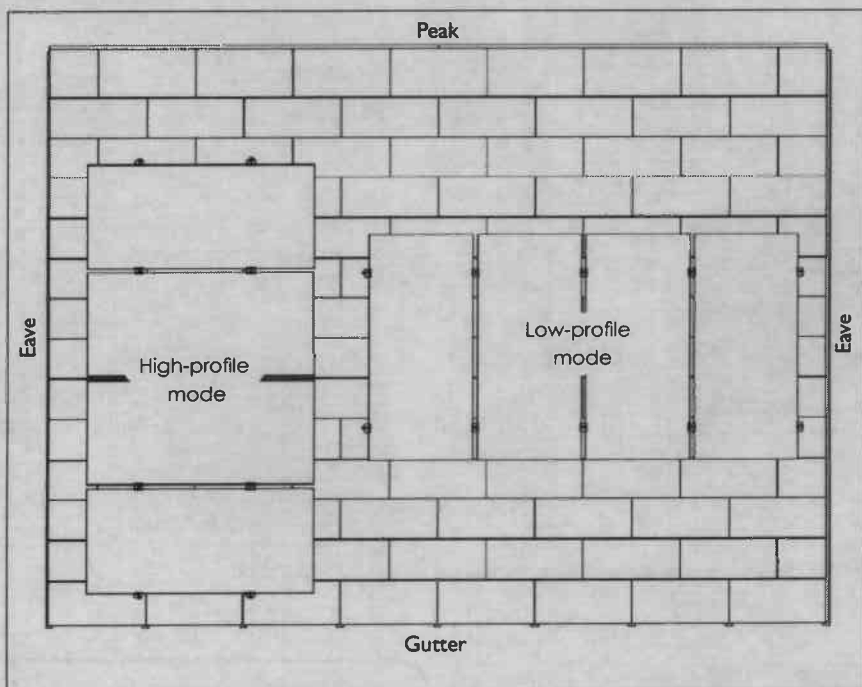


Figure 6. Rails may be placed parallel or perpendicular to rafters.

34

[3.2.2] Laying out L-feet

L-feet (Fig. 7) are used for attachment through existing roofing material, such as asphalt shingles, sheathing or sheet metal to the building structure.

Use Figure 8 or 9 below to locate and mark the position of the L-feet lag screw holes within the installation area.

If multiple rows are to be installed adjacent to one another, it is not likely that each row will be centered above the rafters. Adjust as needed, following the guidelines in Figure 9 as closely as possible.

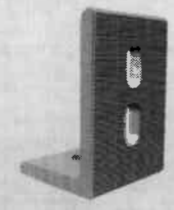


Figure 7

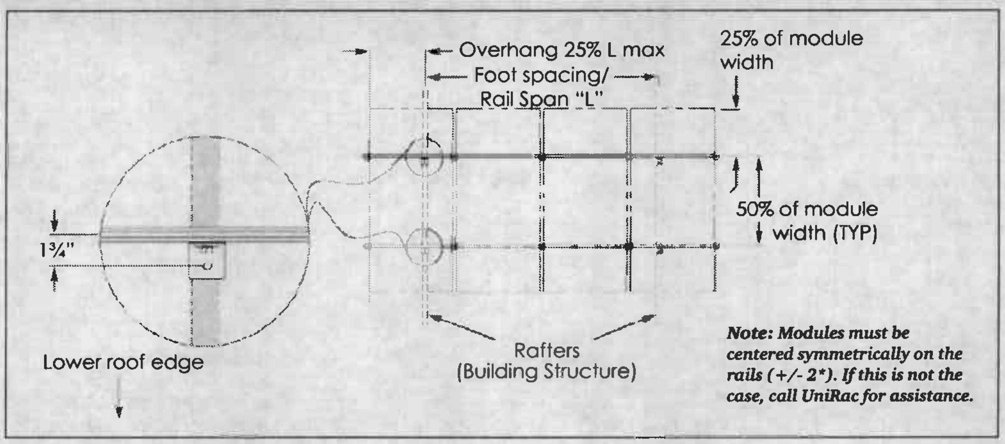


Figure 8. Layout with rails perpendicular to rafters.

Installing L-feet

Drill pilot holes through the roof into the center of the rafter at each L-foot lag screw hole location.

Squirt sealant into the hole, and on the shafts of the lag screws. Seal the underside of the L-feet with a suitable sealant. Consult with the company providing the roofing warranty.

Securely fasten the L-feet to the roof with the lag screws. Ensure that the L-feet face as shown in Figure 8 and 9. For greater ventilation, the preferred method is to place the single-slotted square side of the L-foot against the roof with the double-slotted side perpendicular to the roof. If the installer chooses to mount the L-foot with the long leg against the roof, the bolt slot closest to the bend must be used.

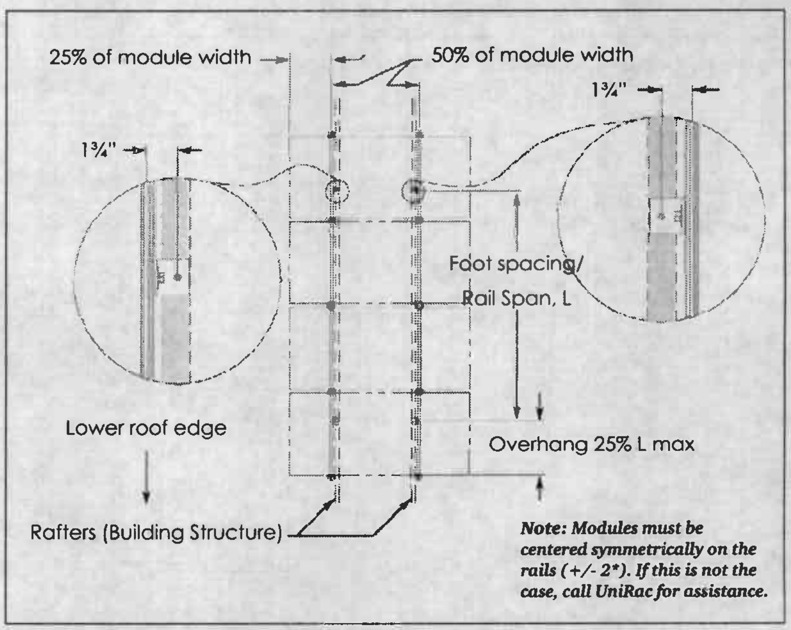


Figure 9. Layout with rails parallel to rafters.

18 47

[3.2.3] Laying out standoffs

Standoffs (Figure 10) are used for flashed installations, such as those with tile and shake shingles.

Use Figure 11 or 12 to locate and mark the location of the standoff lag screw holes within the installation area.

Remove the tile or shake underneath each standoff location, exposing the roofing underlayment. Ensure that the standoff base lies flat on the underlayment, but remove no more material than required for the flashings to be installed properly.

The standoffs must be firmly attached to the building structure.

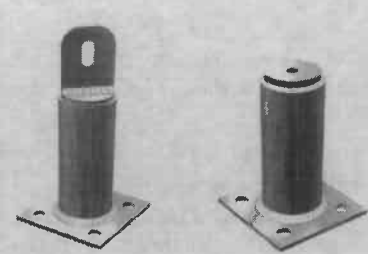
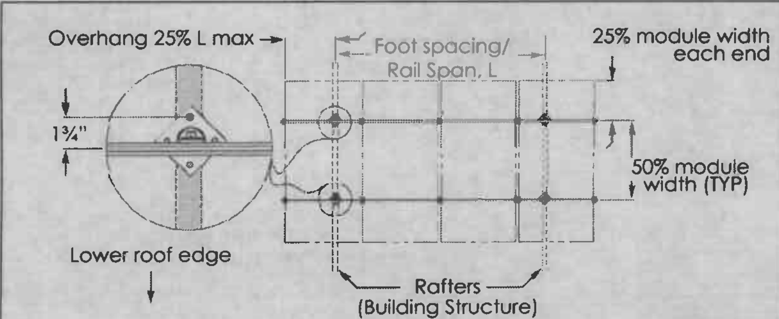


Figure 10. Raised flange standoff (left) and flat top standoff used in conjunction with an L-foot.



Note: Modules must be centered symmetrically on the rails (+/- 2*). If this is not the case, call UniRac for assistance.

Figure 11. Layout with rails perpendicular to rafters.perpendicular to rafters.

If multiple high-profile rows are to be installed adjacent to each other, it may not be possible for each row to be centered above the rafters. Adjust as needed, following the guidelines of Fig. 12 as closely as possible.

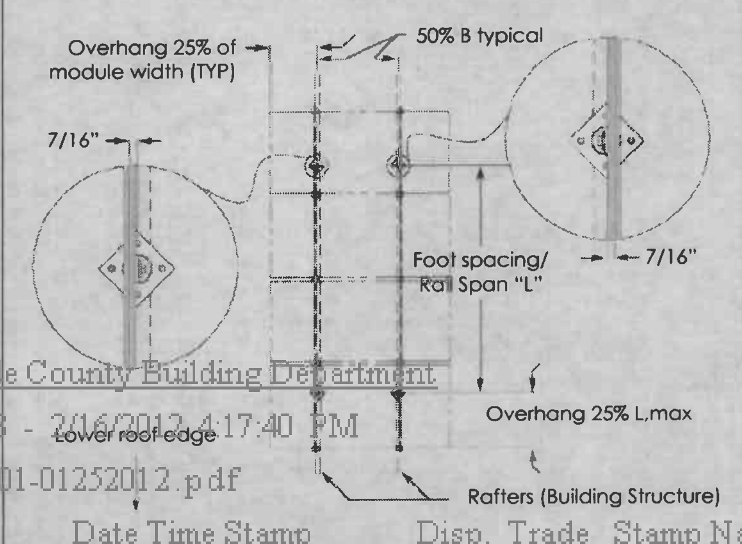
Installing standoffs

Drill 3/16 inch pilot holes through the underlayment into the center of the rafters at each standoff location. Securely fasten each standoff to the rafters with the two 5/16" lag screws.

Ensure that the standoffs face as shown in Figure 11 or 12.

UniRac steel standoffs (1 5/8 " O.D.) are designed for collared flashings available from UniRac. Aluminum two-piece standoffs (1 1/8 " O.D.) take all-metal flashings, also available from UniRac.

Install and seal flashings and standoffs using standard building practices or as the company providing roofing warranty directs.



Note: Modules must be centered symmetrically on the rails (+/- 2"). If this is not the case, call UniRac for assistance.

n8

[3.2.4] Installing SolarMount rails

Keep rail slots free of roofing grit or other debris. Foreign matter will cause bolts to bind as they slide in the slots.

Installing Splices. If your installation uses SolarMount splice bars, attach the rails together (Fig. 13) before mounting the rails to the footings. Use splice bars only with flush installations or those that use low-profile tilt legs.

If using more than one splice per rail, contact UniRac concerning thermal expansion issues.

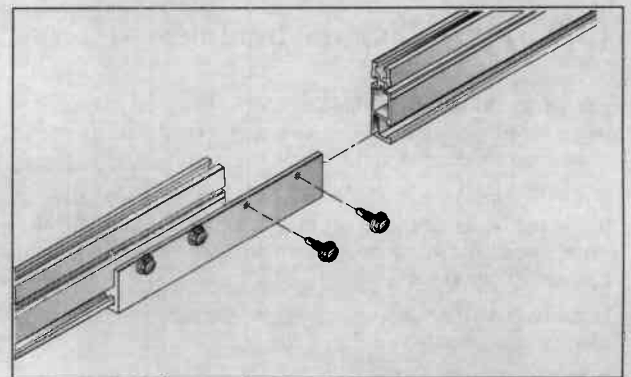


Figure 13. Splice bars slide into the footing bolt slots of SolarMount rail sections.

Mounting Rails on Footings. Rails may be attached to either of two mounting holes in the L-feet (Fig. 14). Mount in the lower hole for a low profile, more aesthetically pleasing installation. Mount in the upper hole for a higher profile, which will maximize airflow under the modules. This will cool them more and may enhance performance in hotter climates.

Slide the ⅜-inch mounting bolts into the footing bolt slots. Loosely attach the rails to the footings with the flange nuts.

Ensure that the rails are oriented to the footings as shown in Figure 8, 9, 11, or 12, whichever is appropriate.

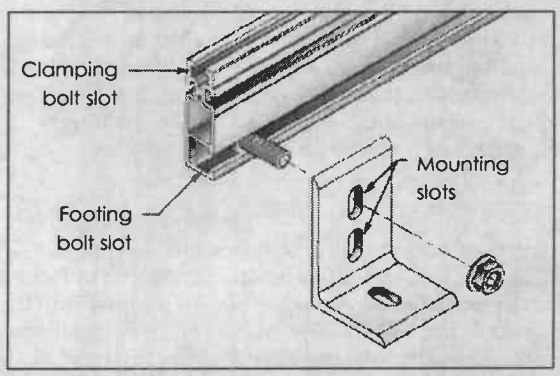


Figure 14. Foot-to-rail splice attachment

Aligning the Rail Ends. Align one pair of rail ends to the edge of the installation area (Fig. 15 or Fig. 16).

The opposite pair of rail ends will overhang the side of the installation area. Do not trim them off until the installation is complete.

If the rails are perpendicular to the rafters (Fig. 15), either end of the rails can be aligned, but the first module must be installed at the aligned end.

If the rails are parallel to the rafters (Fig. 16), the aligned end of the rails must face the lower edge of the roof. Securely tighten all hardware after alignment is complete (28-32 ft lbs).

Mount modules to the rails as soon as possible. Large temperature changes may bow the rails within a few hours if module placement is delayed.

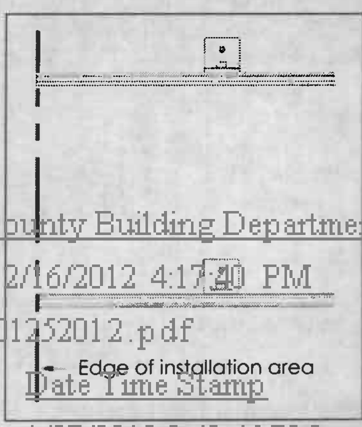


Figure 15. Rails perpendicular to the rafters.

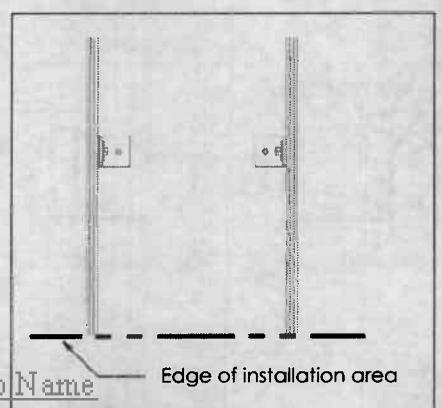


Figure 16. Rails parallel to the rafters.

49

[3.2.5] Installing the modules

Pre-wiring Modules. If modules are the Plug and Play type, no pre-wiring is required, and you can proceed directly to "Installing the First Module" below.

If modules have standard J-boxes, each module should be pre-wired with one end of the intermodule cable for ease of installation. For safety reasons, module pre-wiring should not be performed on the roof.

Leave covers off J-boxes. They will be installed when the modules are installed on the rails.

Installing the First Module. In high-profile installations, the safety bolt and flange nut must be fastened to the module bolt slot at the aligned (lower) end of each rail. It will prevent the lower end clamps and clamping bolts from sliding out of the rail slot during installation.

If there is a return cable to the inverter, connect it to the first module. Close the J-box cover. Secure the first module with T-bolts and end clamps at the aligned end of each rail. Allow half an inch between the rail ends and the end clamps (Fig.18). Finger tighten flange nuts, center and align the module as needed, and securely tighten the flange nuts (15 ft lbs).

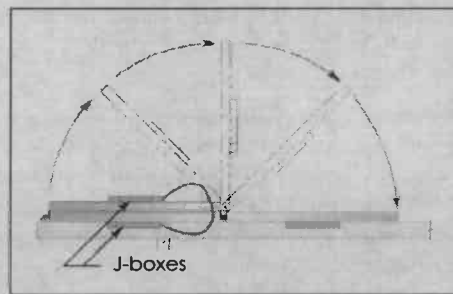


Figure 17

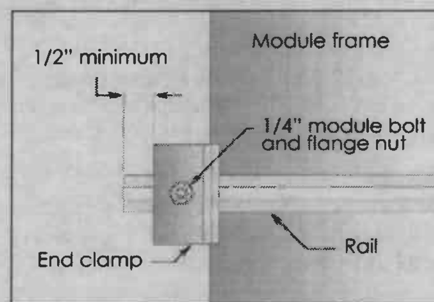


Figure 18

Installing the Other Modules. Lay the second module face down (glass to glass) on the first module. Connect intermodule cable to the second module and close the J-box cover. Turn the second module face up (Fig. 17). With T-bolts, mid-clamps and flange nuts, secure the adjacent sides of the first and second modules. Align the second module and securely tighten the flange nuts (Fig. 19).

For a neat installation, fasten wire management devices to rails with self-drilling screws.

Repeat the procedure until all modules are installed. Attach the outside edge of the last module to the rail with end clamps.

Trim off any excess rail, being careful not to cut into the roof. Allow half an inch between the end clamp and the end of the rail (Fig. 18).

Check that all flange nuts on T-bolts are torqued to 15 ft lbs.

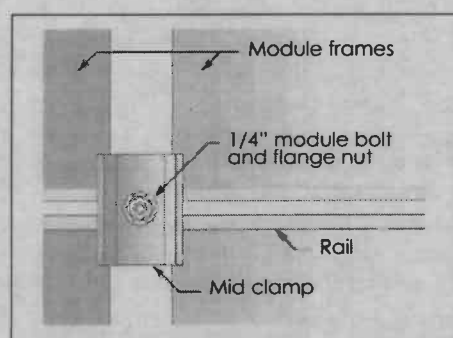


Figure 19

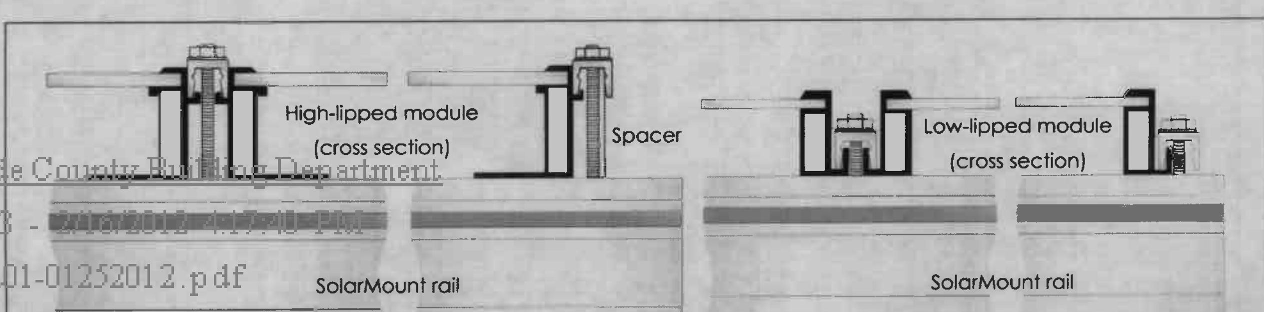


***Figure 20.** Mid clamps and end clamps for lipped-frame modules are identical. A spacer for the end clamps is necessary only if the lips are located high on the module frame.*

60

[3.3] Installing SolarMount with bottom mounting clips

This section covers SolarMount rack assembly where the installer has elected to use bottom mounting clamps to secure modules to the rails. It details the procedure for flush mounting SolarMount systems to a pitched roof.

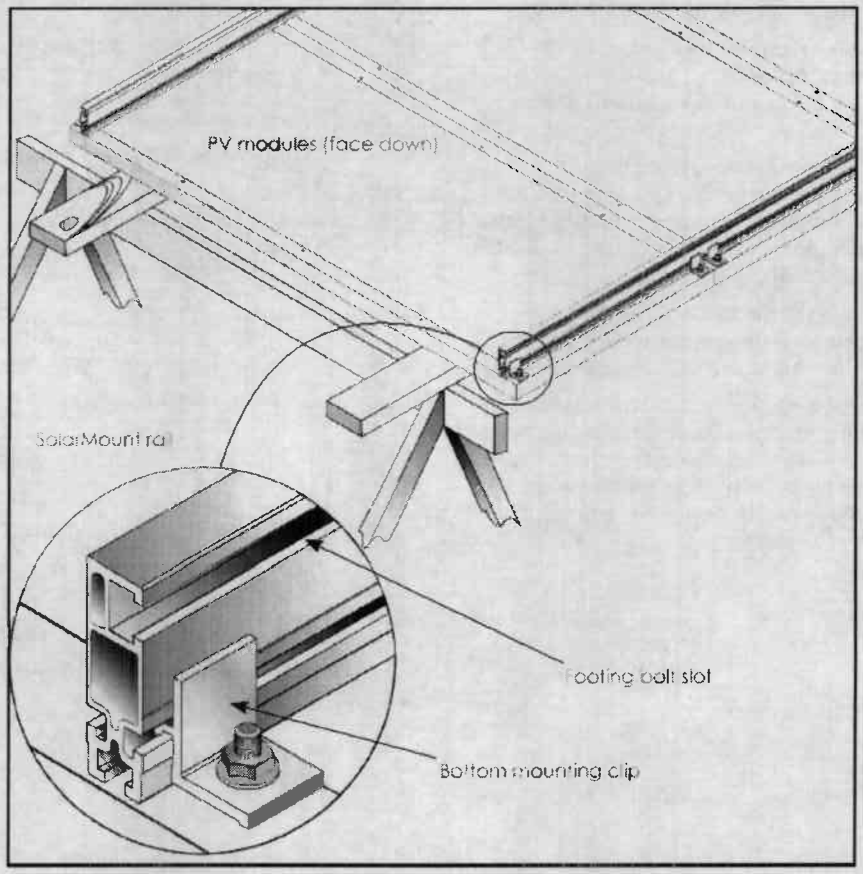


Figure 21. SMR and CB components

Table 16. Wrenches and torque

	Wrench size	Recommended torque (ft-lbs)
¼" hardware	7/16"	15
⅜" hardware	9/16"	30

Note: Torque specifications do not apply to lag bolt connections.

Stainless steel hardware can seize up, a process called galling. To significantly reduce its likelihood, (1) apply lubricant to bolts, preferably an anti-seize lubricant, available at auto parts stores, (2) shade hardware prior to installation, and (3) avoid spinning on nuts at high speed. See Installation Supplement 910, Galling and Its Prevention, at www.unirac.com.

[3.3.1] Planning the installation area

Decide on an arrangement for clips, rails, and L-feet (Fig. 22).

Use Arrangement A if the full width of the rails contacts the module. Otherwise use Arrangement B.

Caution: If you choose Arrangement B, either
(1) use the upper mounting holes of the L-feet or
(2) be certain that the L-feet and clip positions don't conflict.

If rails must be parallel to the rafters, it is unlikely that they can be spaced to match rafters. In that case, add structural supports – either sleepers over the roof or mounting blocks beneath it. These additional members must meet code; if in doubt, consult a professional engineer.

Never secure the footings to the roof decking alone. Such an arrangement will not meet code and leaves the installation and the roof itself vulnerable to severe damage from wind.

Leave enough room to safely move around the array during installation. The width of a rail-module assembly equals the length of one module. Note that L-feet may extend beyond the width of the assembly by as much as 2 inches on each side. The length of the assembly equals the total width of the modules.

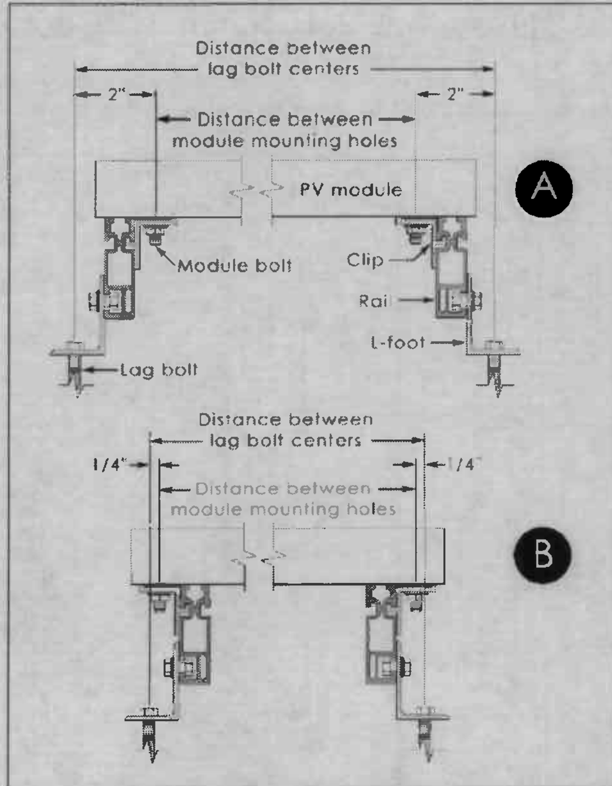


Figure 22. Clip Arrangements A and B

62

[3.3.2] Laying out the installing L-feet

L-feet are used for installation through existing low profile roofing material, such as asphalt shingles or sheet metal. They are also used for most ground mount installations. To ensure that the L-feet will be easily accessible during flush installation:

- Use the PV module mounting holes nearest the ends of the modules.
- Situate the rails so that footing bolt slots face outward.

The single slotted square side of the L-foot must always lie against the roof with the double-slotted side perpendicular to the roof.

Foot spacing (along the same rail) and rail overhang depend on design wind loads.

Install half the L-feet:

- If rails are perpendicular to rafters (Fig. 23), install the feet closest to the lower edge of the roof.
- If rails are parallel to rafters (Fig 24), install the feet for one of the rails, but not both.

For the L-feet being installed now, drill pilot holes through the roofing into the center of the rafter at each lag screw hole location.

Squirt sealant into the hole and onto the shafts of the lag screws. Seal the underside of the L-feet with a sealant. Securely fasten the L-feet to the building structure with the lag screws. Ensure that the L-feet face as shown in Figure 23 or Figure 24.

Hold the rest of the L-feet and fasteners aside until the panels are ready for the installation.

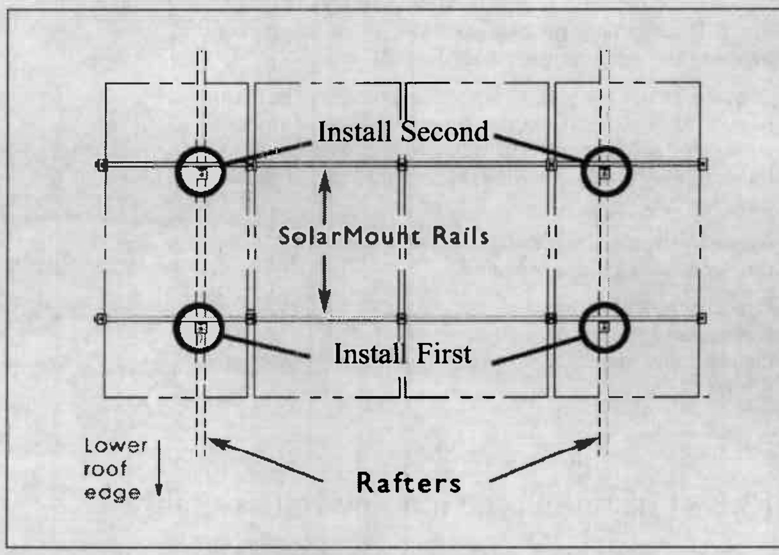


Figure 23. Layout with rails perpendicular to rafters.

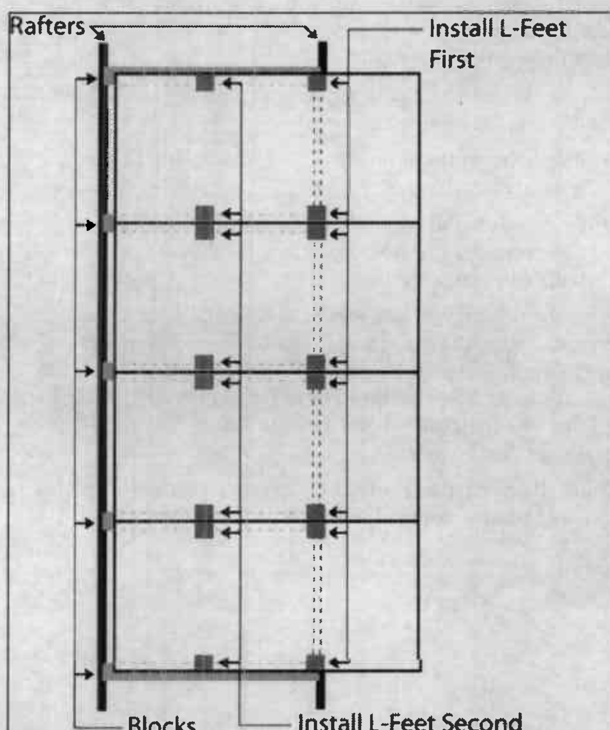


Figure 24. Layout with rails parallel to rafters.

53

[3.3.3] Attaching modules to the rails

Lay the modules for a given panel face down on a surface that will not damage the module glass. Align the edges of the modules and snug them together (Fig. 21, page22).

Trim the rails to the total width of the modules to be mounted. Place a rail adjacent to the outer mounting holes. Orient the footing bolt slot outward. Place a clip slot adjacent to the mounting holes, following the arrangement you selected earlier.

Assemble the clips, mounting bolts, and flange nuts. Torque the flange nuts to 15-foot-pounds.

Wire the modules as needed. For safety reasons, module wiring should not be performed on a roof. For a neat installation, fasten cable clamps to rails with self-tapping screws.

[3.3.4] Installing the module-rail assembly

Bring the module-rail assembly to the installation site. Keep rail slots free of debris that might cause bolts to bind in the slots.

Consider the weight of a fully assembled panel. UniRac recommends safety lines whenever lifting one to a roof.

Align the panel with the previously installed L-feet. Slide 3/8 inch L-foot mounting bolts onto the rail and align them with the L-feet mounting holes. Attach the panel to the L-feet and finger tighten the flange nuts.

Rails may be attached to either of two mounting holes in the footings (Fig. 25).

- Mount in the lower hole for a low, more aethetically pleasing installation.
- Or mount in the upper hole to maximize a cooling airflow under the modules. This may enhance performance in hotter climates.

Adjust the position of the panel as needed to fit the installation area. Slide the remaining L-feet bolts onto the other rail, attach L-feet, and finger tighten with flange nuts. Align L-feet with mounting holes previously drilled into the roof. Install lag bolts into remaining L-feet as described in "Laying out and installing L-feet" above.

Torque all footing flange nuts to 30 pounds. Verify that all lag bolts are securely fastened.

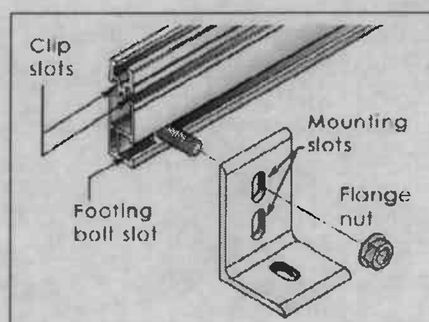


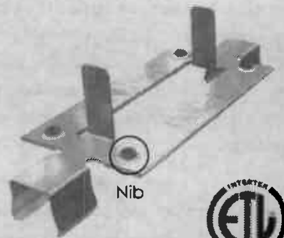
Figure 25. Leg-to-rail attachment

54

[3.4] Installing SolarMount with grounding clips and lugs

Clips and lugs are sold separately.

UGC-1



Conforms to UL Standard 467

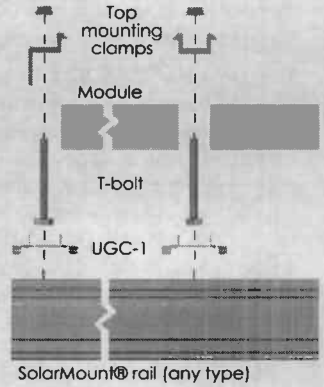


Figure 26. Slide UGC-1 grounding clip into top mounting slot of rail. Torque modules in place on top of clip. Nibs will penetrate rail anodization and create grounding path through rail (see Fig. 3, reverse side).

UGL

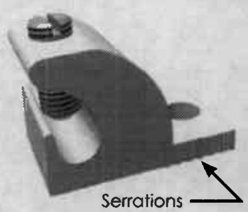
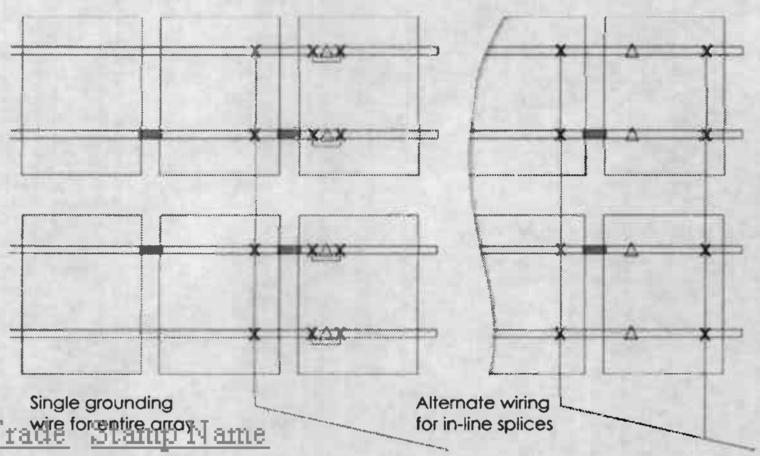


Figure 27. Slide ¼-inch hexhead bolt into top mouning slot of any SolarMount® rail (standard, HD, or light). Secure nut with 7/16-inch crescent wrench with sufficient torque for lug serrations to penetrate anodized surface of rail.

Figure 28. Place grouding clips, lugs, and copper wire (6–10 AWG). Place a loop in the wire around splices to prevent tension. Be sure wiring between rails is not taut.

KEY

PV module
SolarMount rail (any type)
△ Rail splice
X Grounding lug
Grounding clip
— Copper wire



55

10 year limited Product Warranty, 5 year limited Finish Warranty

UniRac, Inc., warrants to the original purchaser ("Purchaser") of product(s) that it manufactures ("Product") at the original installation site that the Product shall be free from defects in material and workmanship for a period of ten (10) years, except for the anodized finish, which finish shall be free from visible peeling, or cracking or chalking under normal atmospheric conditions for a period of five (5) years, from the earlier of 1) the date the installation of the Product is completed, or 2) 30 days after the purchase of the Product by the original Purchaser ("Finish Warranty").

The Finish Warranty does not apply to any foreign residue deposited on the finish. All installations in corrosive atmospheric conditions are excluded. The Finish Warranty is VOID if the practices specified by AAMA 609 & 610-02 – "Cleaning and Maintenance for Architecturally Finished Aluminum" (www.aamanet.org) are not followed by Purchaser. This Warranty does not cover damage to the Product that occurs during its shipment, storage, or installation.

This Warranty shall be VOID if installation of the Product is not performed in accordance with UniRac's written installation instructions, or if the Product has been modified, repaired, or reworked in a manner not previously authorized by UniRac IN WRITING, or if the Product is installed in an environment for which it was not designed. UniRac shall not be liable for consequential, contingent or incidental damages arising out of the use of the Product by Purchaser under any circumstances.

If within the specified Warranty periods the Product shall be reasonably proven to be defective, then UniRac shall repair or replace the defective Product, or any part thereof, in UniRac's sole discretion. Such repair or replacement shall completely satisfy and discharge all of UniRac's liability with respect to this limited Warranty. Under no circumstances shall UniRac be liable for special, indirect or consequential damages arising out of or related to use by Purchaser of the Product.

Manufacturers of related items, such as PV modules and flashings, may provide written warranties of their own. UniRac's limited Warranty covers only its Product, and not any related items.

1411 Broadway NE, Albuquerque NM 87102-1545 USA • 505.242.6411 • Fax 505.242.6412

64

Ascent Consulting Engineering
North Winds Center
High Mountain Road
Ringwood, NJ 07456
Tel. No. 973-557-6080
Fax No. 973-835-5924
E-mail: jamlight@bellatlantic.net

March 12, 2008

Unirac, Inc.
1411 Broadway Blvd. NE
Albuquerque, NM 87102

To: Building Department or Others:

RE: Engineer's Notice of Evaluation for UniRac SolarMount™ Universal PV Module Mounting System

Dear Sir:

I have reviewed Unirac SolarMount™ "Code-Compliant Installation Manual 227", copyright February 2008 and certify that the information and results are accurate. To determine the design level forces, the appropriate wind speed shall be determined as prescribed by local jurisdiction requirements and applied in accordance to the 2004 Florida Building Code (FBC) with the 2005 and 2006 Supplements. The FBC requires that wind loading be determined based upon ASCE 7-02 and Unirac's Manual 227 utilizes the newer ASCE 7-05 that matches the ASCE 7-02 wind loads using Method 1 for which Unirac Table 2 is based upon, that which is dependent upon conditions of spatial form, height and other structure parameters that are specified in the code provisions for determining the applied wind loading pressures imposed onto the Unirac SolarMount™ rails supporting solar panels. The SolarMount™ railing and anchorage requirements for the installation are properly represented in the Installation Manual 227.

For other conditions, the determination of wind pressures should be determined by the aforementioned Florida Building Code and ASCE 7 procedures.

57

The design verification is based on:

I. ASCE7-02 – ASCE Standard
II. "Steel Construction Manual," 13th Ed., American Institute of Steel Construction, Chicago, IL, 2005.
III. "Aluminum Design Manual", The Aluminum Association, Washington D.C., 2005.
IV. Mechanical Properties and Static Load Testing of Unirac extruded rails and related components obtained from Dr. Walter Gerstle, PE, Department of Civil Engineering, University of New Mexico, Albuquerque, NM

Use:

Unirac SolarMount™ is evaluated for use in locations where wind pressure requirements do not exceed 50 psf. For loading in excess of 50 psf, Unirac or a licensed professional should be contacted for suitability of installation.

By this letter, I certify that the Unirac SolarMount™ assembly, when installed in accordance with the Installation Manual 227 will meet the requirements of the building codes adopted by Florida. Others should evaluate the structure to which the Unirac SolarMount™ system is to be connected on a case-by-case basis, per Part I – Installer's Responsibilities of the Installation Manual, to ensure its adequacy to accept attachments and to support all applied loadings per the building code.

Please call me if you have any questions or concerns.

Sincerely,

3/12/08

James A. Marx, Jr. PE
Professional Engineer
10 High Mountain Road
Ringwood, NJ 07456
(908-557-6080)

FL Lic. No. 45024

cc: Aaron Dixon, Unirac, Inc.

68

Report:
Laboratory Structural Testing of UniRac Rails and Connectors

Prepared for:
John Liebendorfer and Tim Hool
UniRac, Inc
3201 University Blvd SE, Suite 110
Albuquerque, NM 87106-5635

Phone: (505)242-6411
Email: johnl@unirac.com

By:
Walter H. Gerstle, Ph.D., P.E.
Department of Civil Engineering
University of New Mexico
Albuquerque, NM 87131

Phone: (505)277-3458
Email: Gerstle@unm.edu

March 7, 2003

59

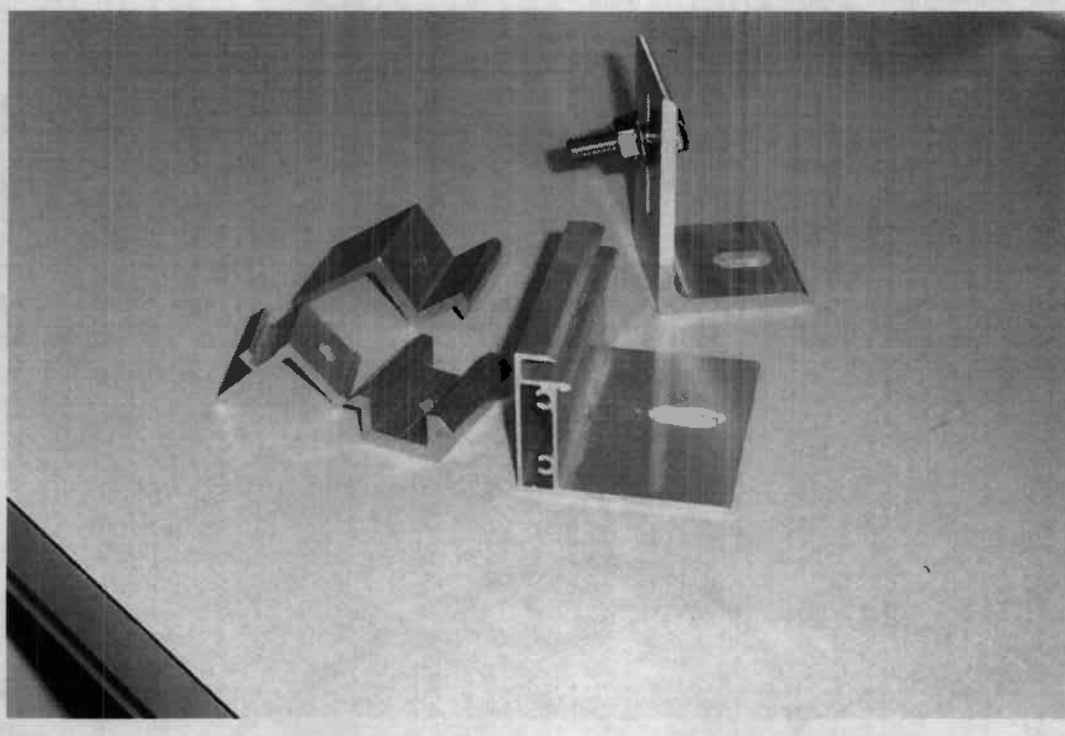
Introduction

This report summarizes the results of laboratory structural testing of UniRac rails and connections. Fourteen tests were performed over several weeks during February and March of 2003.

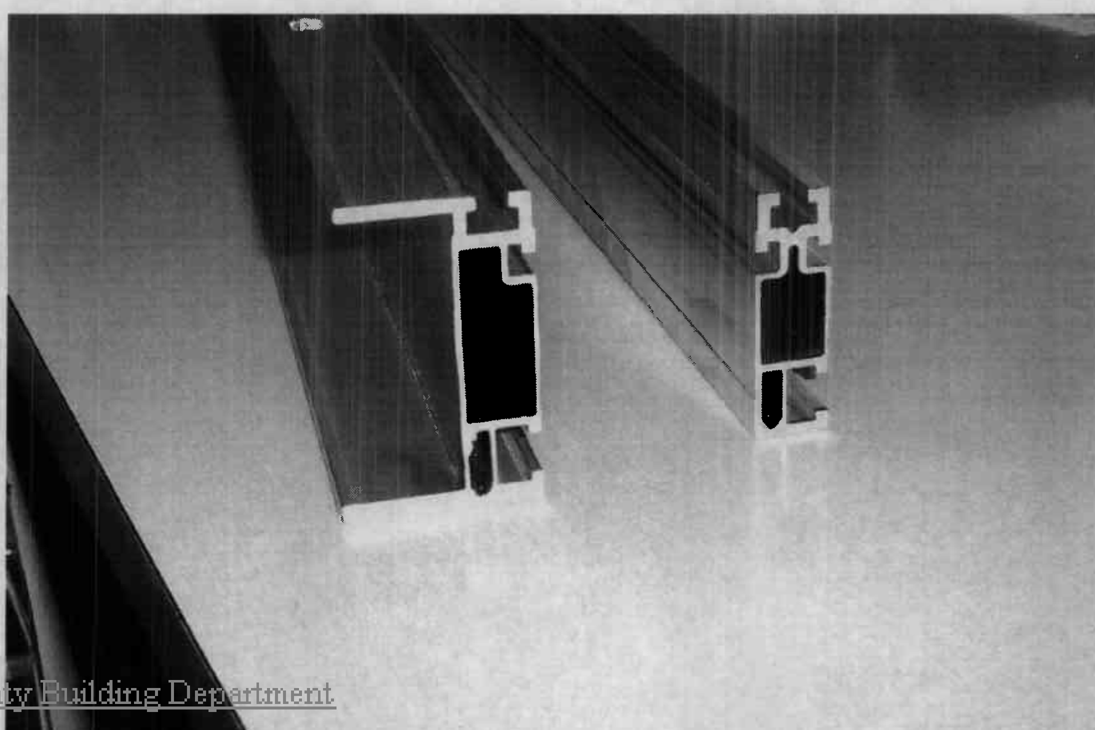
The following structural tests were performed:

1. Bending strength of new SolarMount rail. Load versus deflection was recorded.
2. Bending strength of new Heavy Duty SolarMount rail. Load versus deflection was recorded.
3. Load versus displacement of module frame, connected using UniRac top-down end-clamp, to SolarMount rail using one ¼" T-bolt torqued to 10 ft-lbs.
4. Load versus displacement of module frame, connected using UniRac top-down mid-clamp, to SolarMount rail using one ¼" T-bolt torqued to 10 ft-lbs.
5. Load Versus displacement of module frame connected using bottom-up clip, to SolarMount rail using ¼" T-bolt torqued to 10 ft-lbs.
6. Load versus displacement of SolarMount Rail connected to test frame with 3/8" T-bolt using a single 2"x3"x 3/16" angle bracket foot.
7. Load versus displacement of 2-1/2" diameter standard steel pipe collar connected to 2" diameter standard steel pipe with one 3/8" diameter set screw torqued to 35 ft-lbs.
8. Load versus displacement of 2-1/2" diameter standard steel pipe collar connected to 2" diameter standard steel pipe with two 3/8" diameter set screws torqued to 35 ft-lbs.
9. Load versus displacement of 2-1/2" diameter standard steel pipe collar connected to 2" diameter standard steel pipe with three 3/8" diameter set screws torqued to 35 ft-lbs.
10. Load versus displacement of 2-1/2" diameter standard steel pipe collar connected to 2" diameter standard steel pipe with four 3/8" diameter set screws torqued to 35 ft-lbs.
11. Load versus displacement of 2-1/2" diameter standard steel pipe collar connected to 2" diameter standard steel pipe with one 3/8" diameter Tek screw torqued to 35 ft-lbs.
12. Load versus displacement of 2-1/2" diameter standard steel pipe collar connected to 2" diameter standard steel pipe with two 3/8" diameter Tek screws torqued to 35 ft-lbs.
13. Load versus displacement of 2-1/2" diameter standard steel pipe collar connected to 2" diameter standard steel pipe with three 3/8" diameter Tek screws torqued to 35 ft-lbs.
14. Load versus displacement of 2-1/2" diameter standard steel pipe collar connected to 2" diameter standard steel pipe with four 3/8" diameter Tek screws torqued to 35 ft-lbs.

Each of the tests is described in the following pages. The items tested are shown in photos on the next page.



Connecting Items Tested.



New Heavy Duty SolarMount Rail and New SolarMount Rail Cross-Sectional Views.

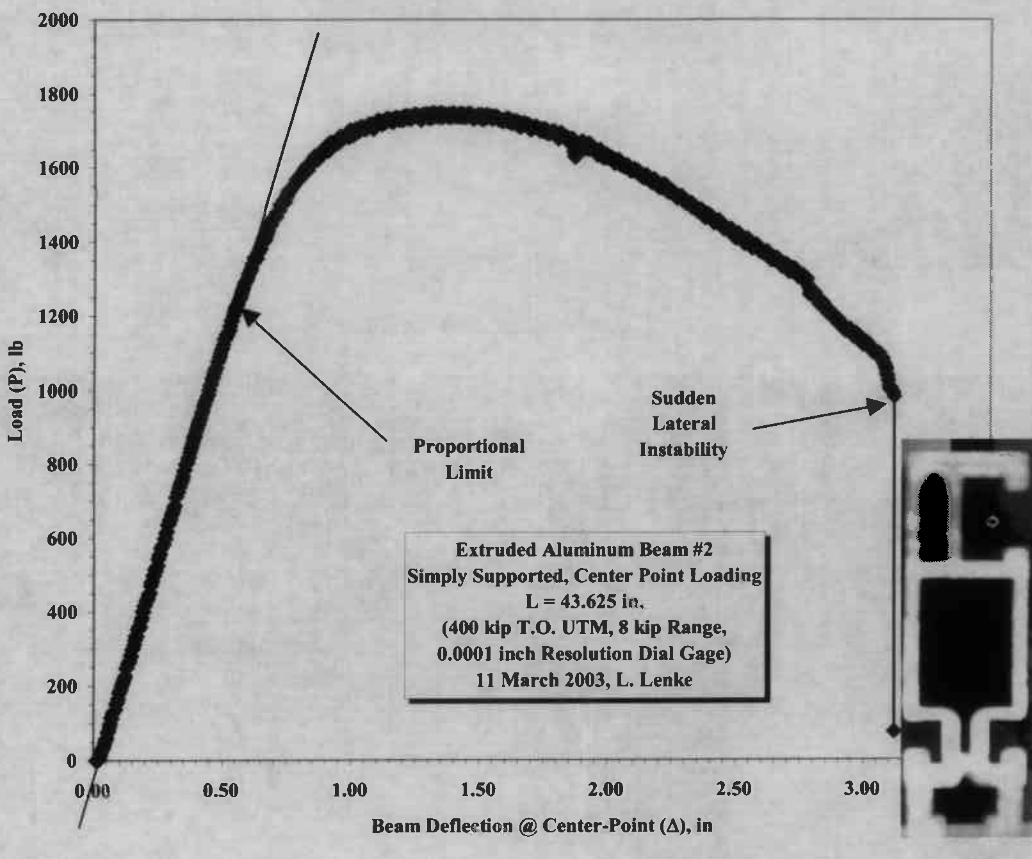
41

Bending Strength of New SolarMount Rail

The new SolarMount rail was tested as a simply-supported beam with center-point loading. The span of the beam was 43.625 inches.

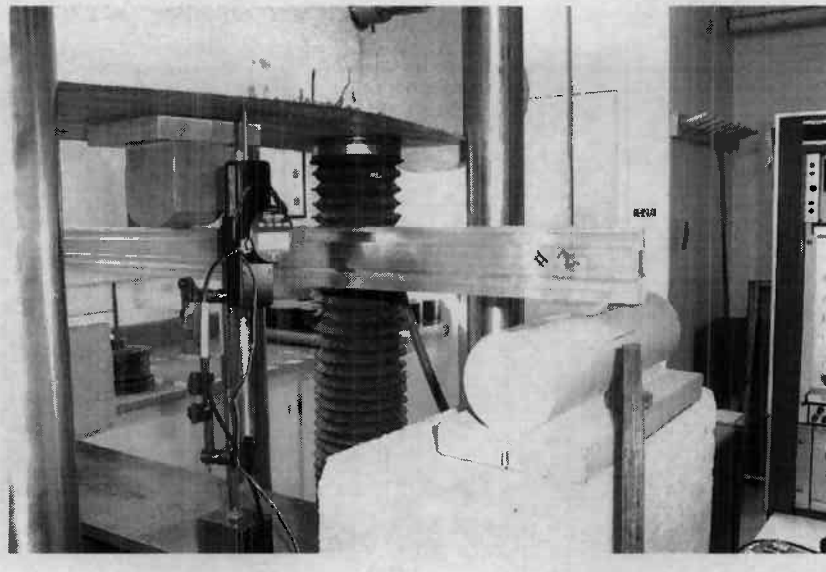
According to our structural calculations, the bending strength of the beam (according to the Aluminum Design Manual) is $M = F_{allow} \times S = 19$ KSI x .3694 in^3 = 7.019 kip-in. The actual bending strength of the member tested is 1.750 kip x (43.625in)/4 = 19.09 kip-in.

The member actually failed first by gross yielding in bending, followed by lateral instability in the post-peak regime, as shown in the following graph. The following photographs also show the beam behavior.

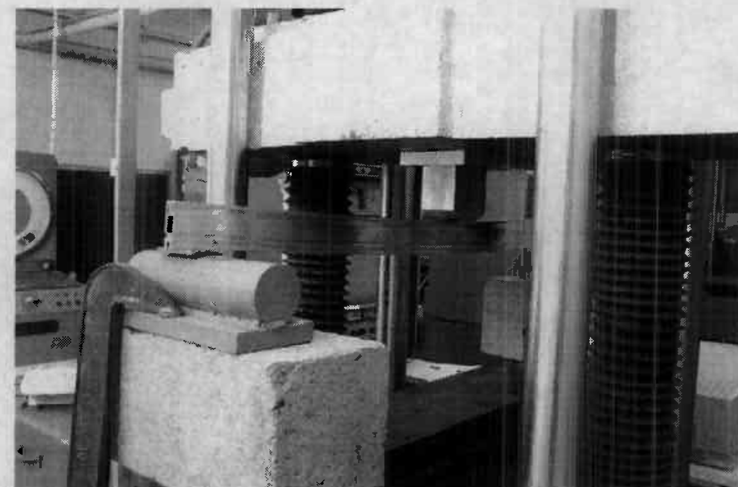


Load versus Deflection of New UniRac Rail.

62

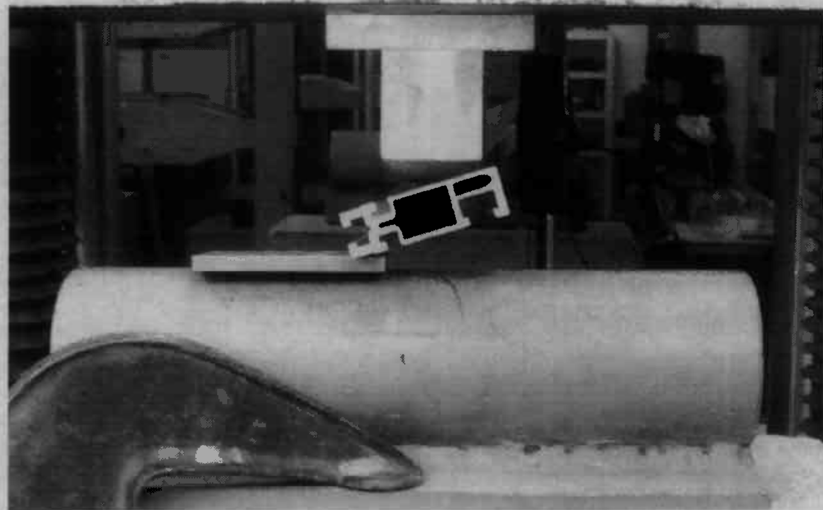


Test Set-Up, New UniRac Rail.

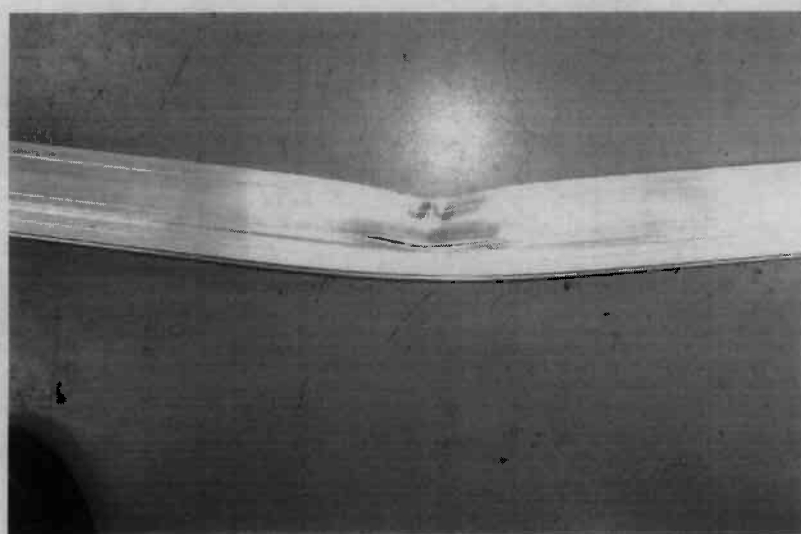


Test Set-Up, New UniRac Rail, Showing Deflection.

63



Lateral Instability, New UniRac Rail.



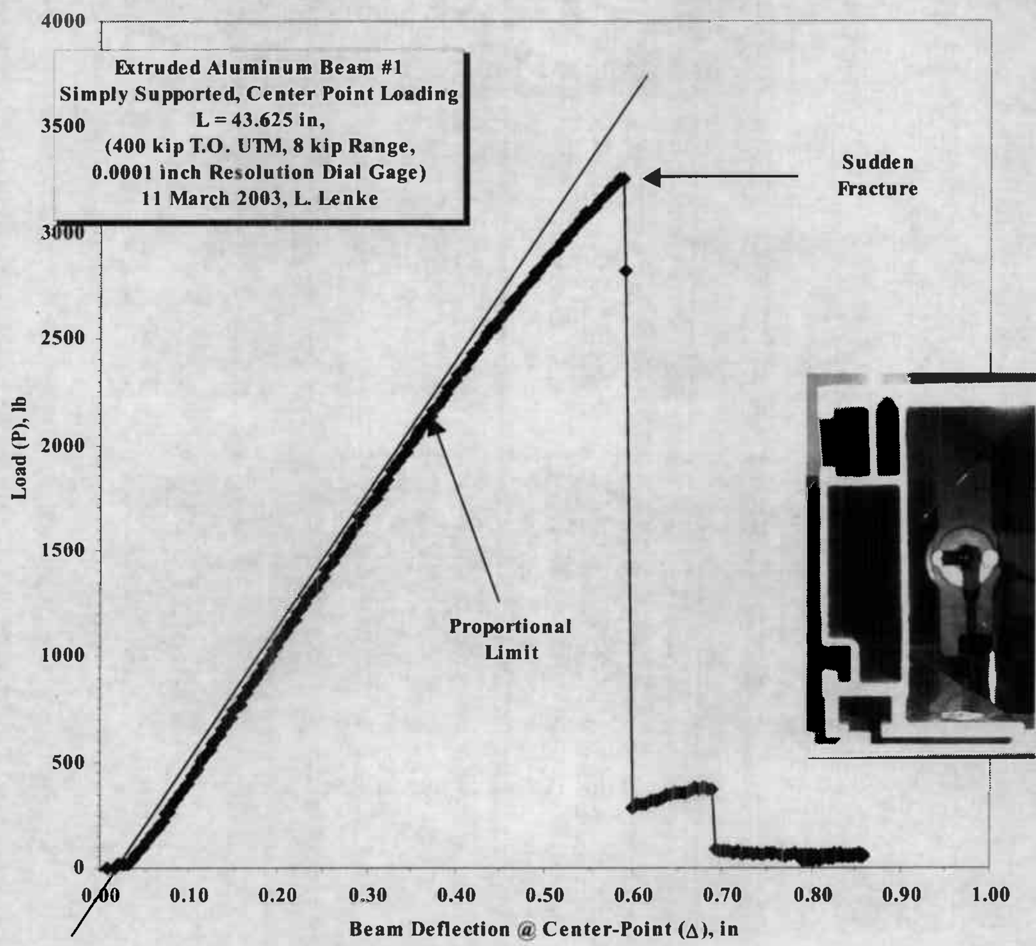
Local Buckling and Fracture, New UniRac Rail.

Bending Strength of New Heavy Duty SolarMount Rail

The New Heavy Duty SolarMount rail was tested as a simply-supported beam with center-point loading. The span of the beam was 43.625 inches.

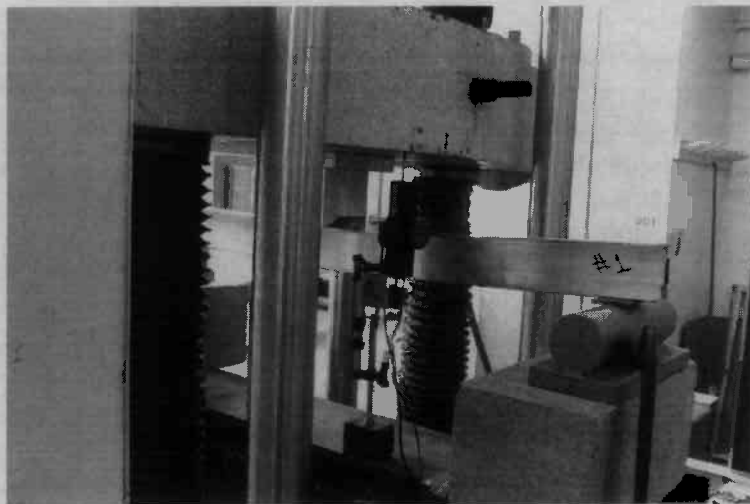
According to our structural calculations, the bending strength of the beam (according to the Aluminum Design Manual) is $M = F_{allow} \times S = 19$ KSI x .9025 in^3 = 17.14 kip-in. The actual bending strength of the member tested is 3.400 kip x (43.625in)/4 = 37.08 kip-in.

The member actually failed by initial plastification, followed suddenly by fracture initiating at on of the holes punched in the rail flange, as shown in the following graph. The following photographs also show the beam behavior.

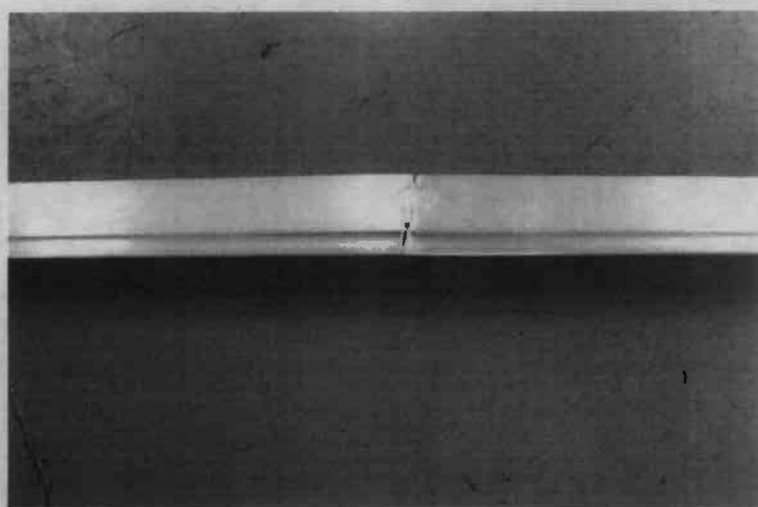


Load versus Deflection of New Heavy Duty UniRac Rail.

65



Test Set- Up of New Heavy Duty UniRac Rail.



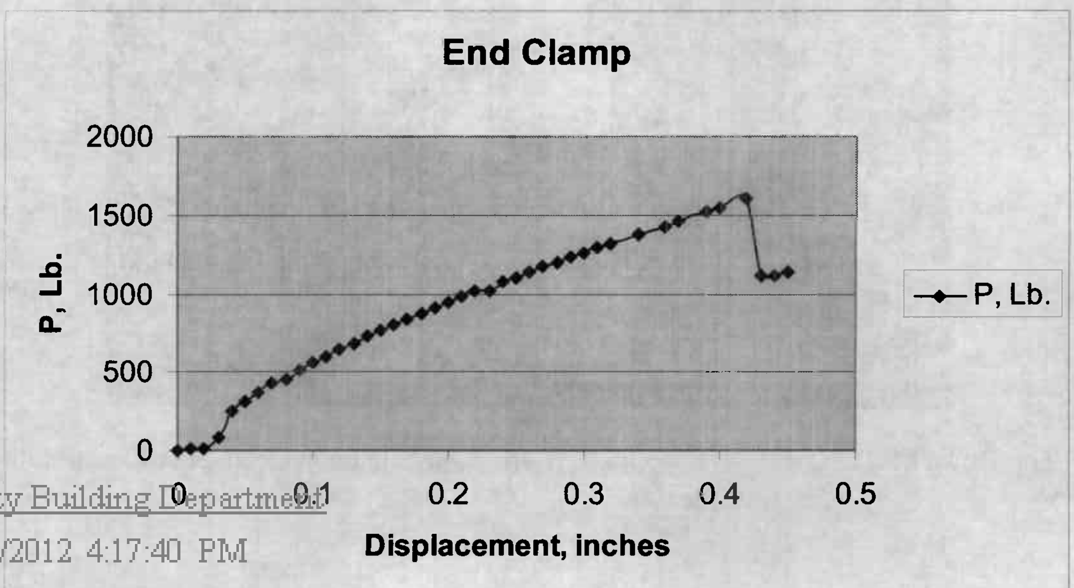
Crack in New Heavy Duty UniRac Rail.

64

Load and Deformation of UniRac Top-Down End-Clamp

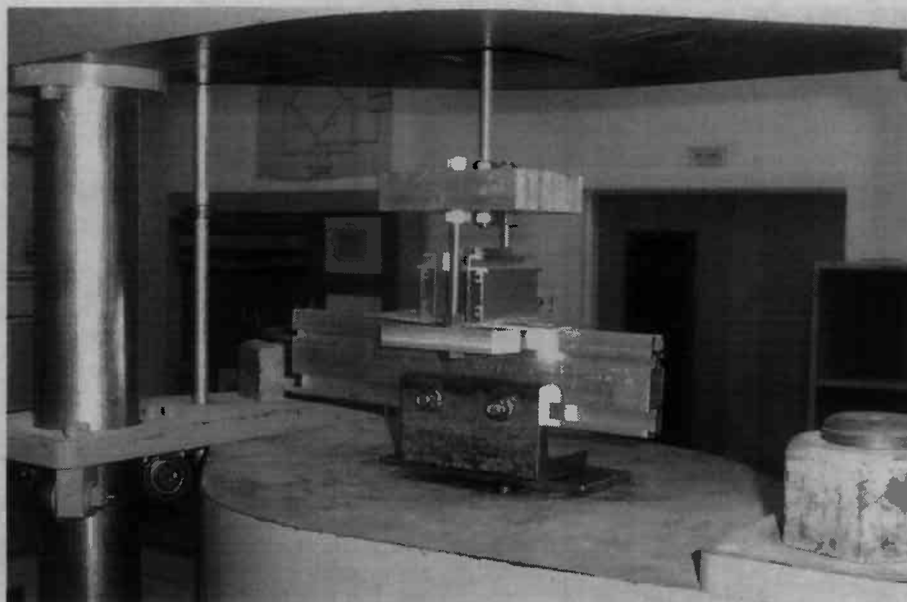
The following picture shows the test configuration. The ¼" diameter T-bolt was torqued to 10 ft-lbs. There was some concern about the high probability of contractors installing the T-bolt and/or the end clamp incorrectly. Ultimate failure was by the T-bolt breaking through the top flange of the SolarMount rail. The load versus deflection curve is shown in the graph below.

Photo of Top-Down End Clamp Test Configuration.

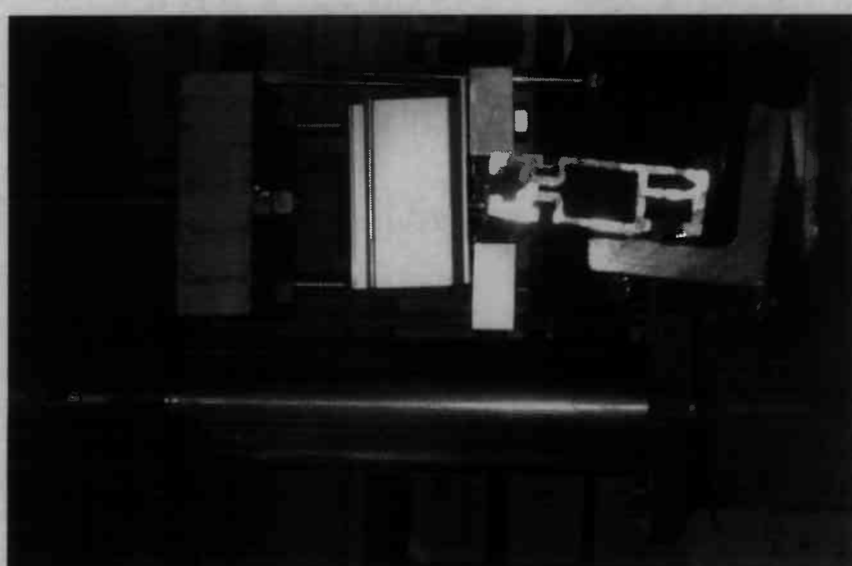


67

Load and Deformation of UniRac Top-Down Mid-Clamp

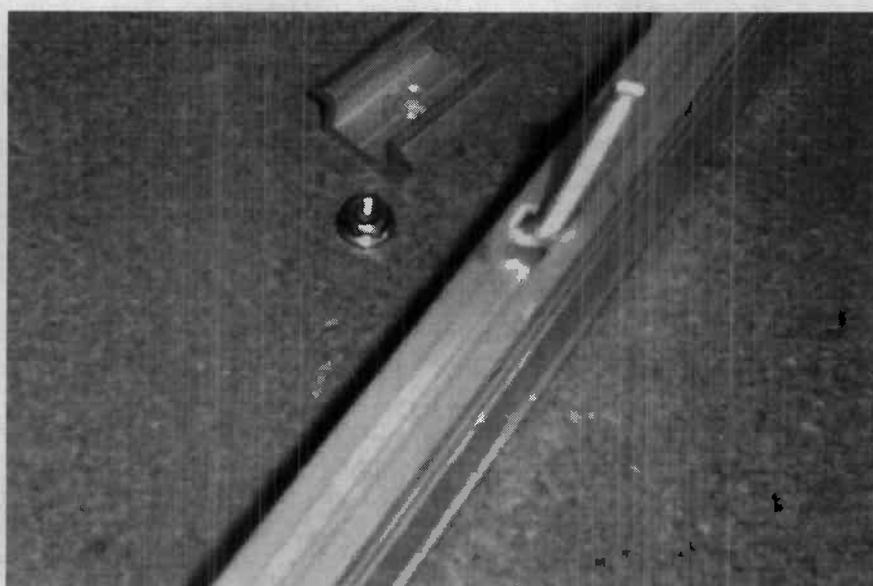


Setup of Top-Down Mid Clamp Test.

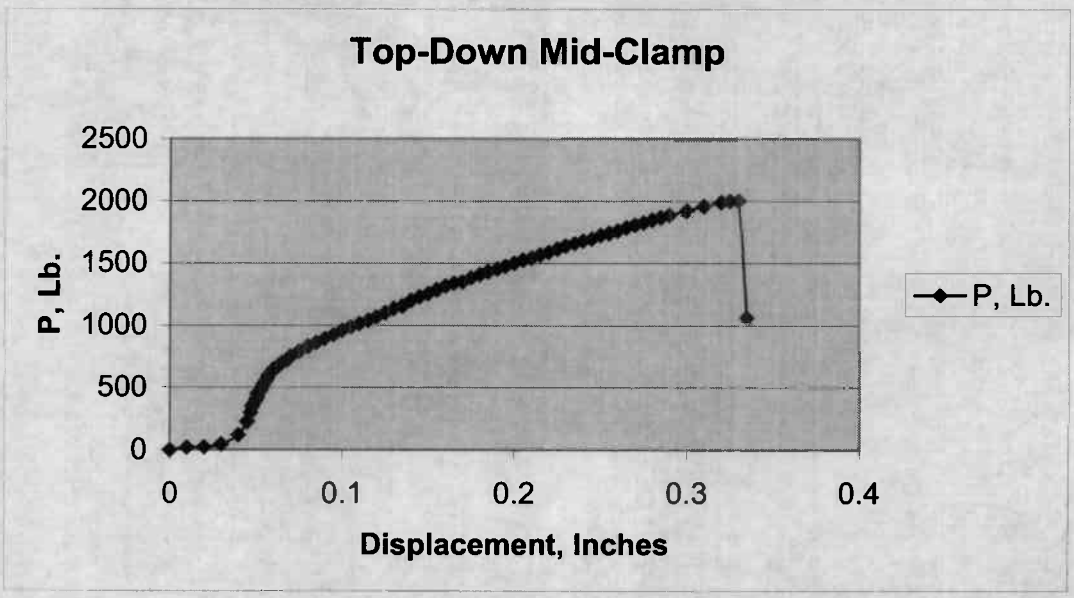


Top-Down Mid Clamp Test: Showing Lift-off of Module Frame from SolarMount Rail.

68



Top-Down Mid Clamp Test: Showing Failure of SolarMount Rail Lip.



69

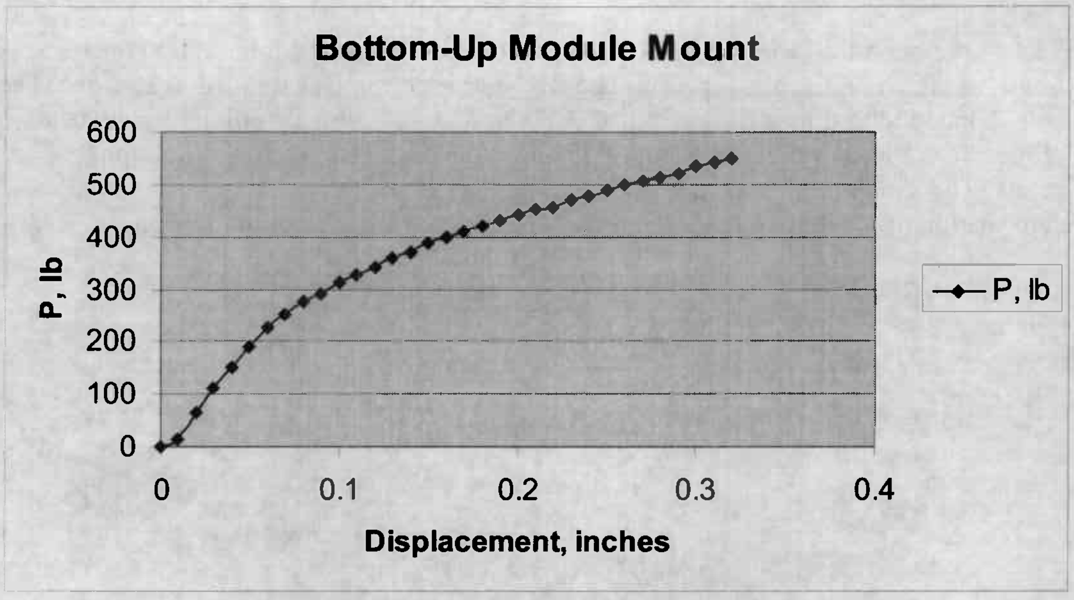
Load and Deformation of Bottom-Up Clip

The bottom-up clip was used to connect a SolarMount rail to a module frame, as shown in the photo below. The ¼” diameter bolt was torqued to 10 ft-lbs. Ultimate failure was by bending of the module frame, as shown in both pictures below. Significant observable loosening of the connection resulted for loads in excess of about 300 lbs.

Test Configuration for Bottom-Up Clip.

Deformation of Bottom-Up Clip Showing Loosening Behavior.

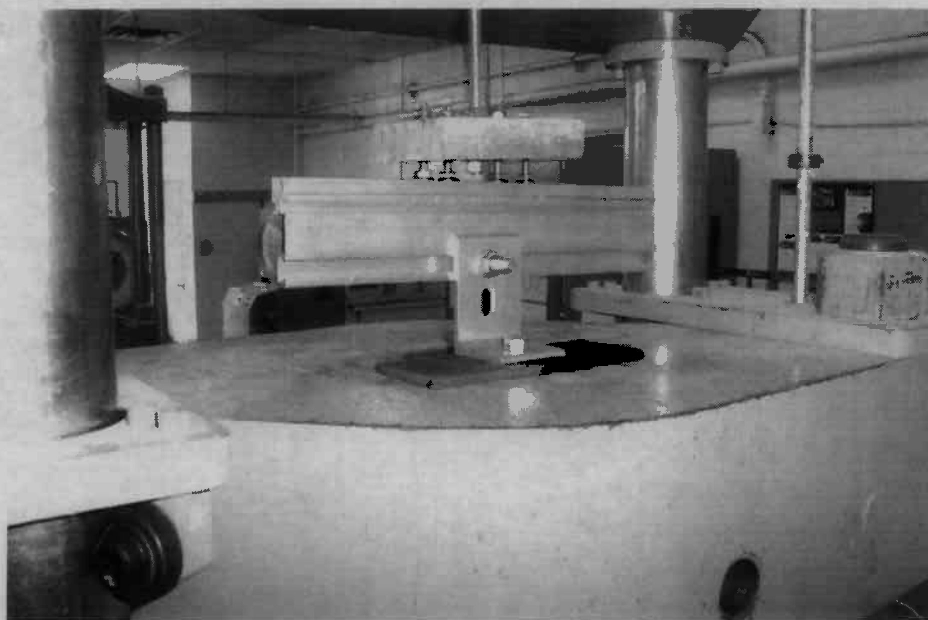
10


Bottom-Up Module Mount
600
500
400
300
200
100
0
0
0.1
0.2
0.3
0.4
P, lb
Displacement, inches
P, lb

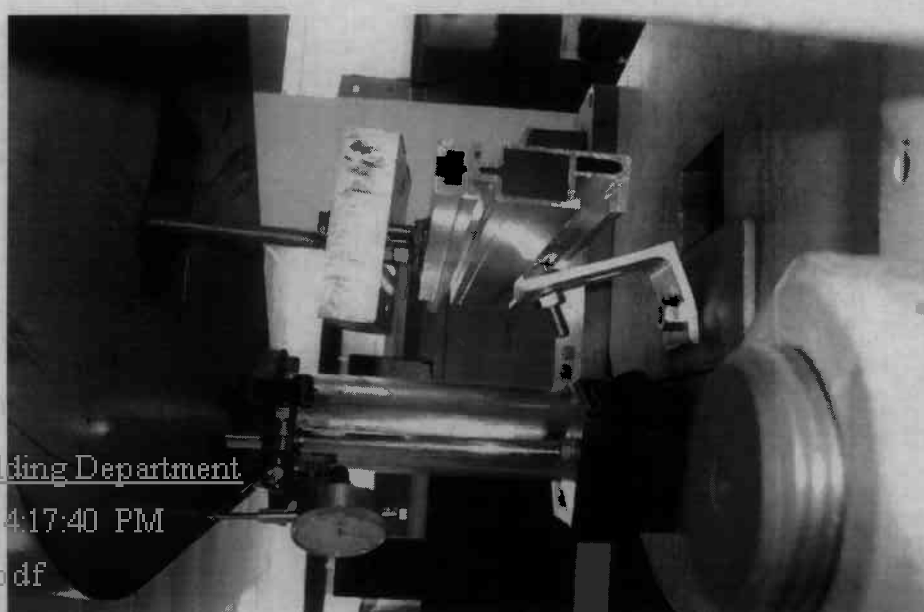
71

Load and Deformation of Angle Bracket Foot

A 2"x3"x1/8" angle bracket was used to connect a SolarMount rail to the test frame, as shown in the photo below. The 3/8" diameter bolt was torqued to 35 ft-lbs. The bolt slipped in the slotted hole at a load of about 550 lbs. Ultimate failure was by bending of the clip angle, as well as pull-out of the top of the T-bolt, as shown in both picture below. The T-bolt pulled out at a load of about 500 lbs. There was also observable deformation of the bottom lip of the SolarMount rail, were it bares on the bolt.

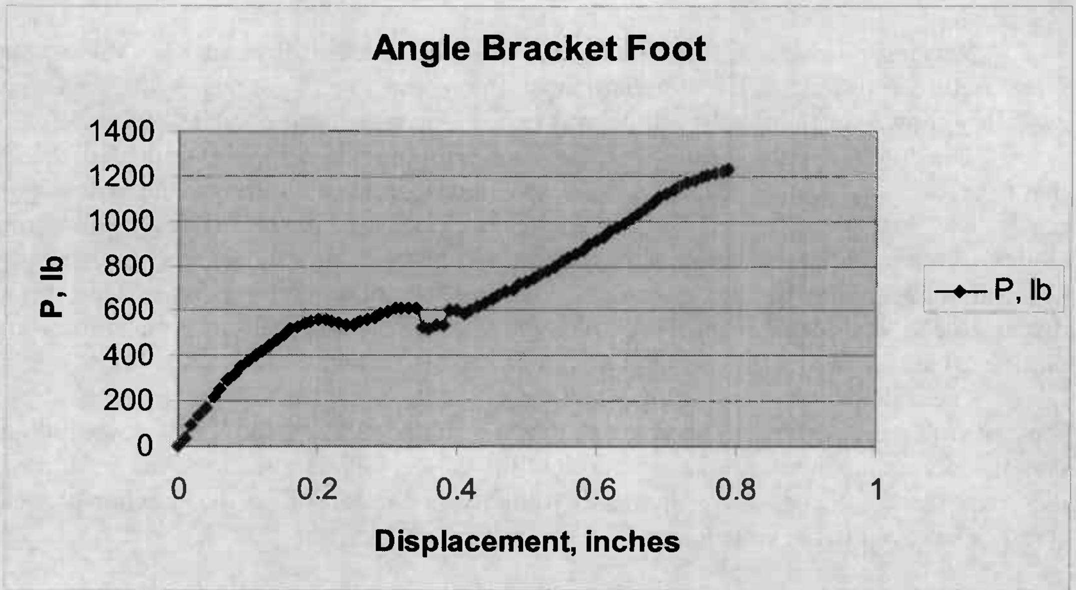


Angle Bracket Load Test Setup.



Angle Bracket at Load Close to Failure.

12


Angle Bracket Foot
P, lb
1400
1200
1000
800
600
400
200
0
0
0.2
0.4
0.6
0.8
1
Displacement, inches
P, lb

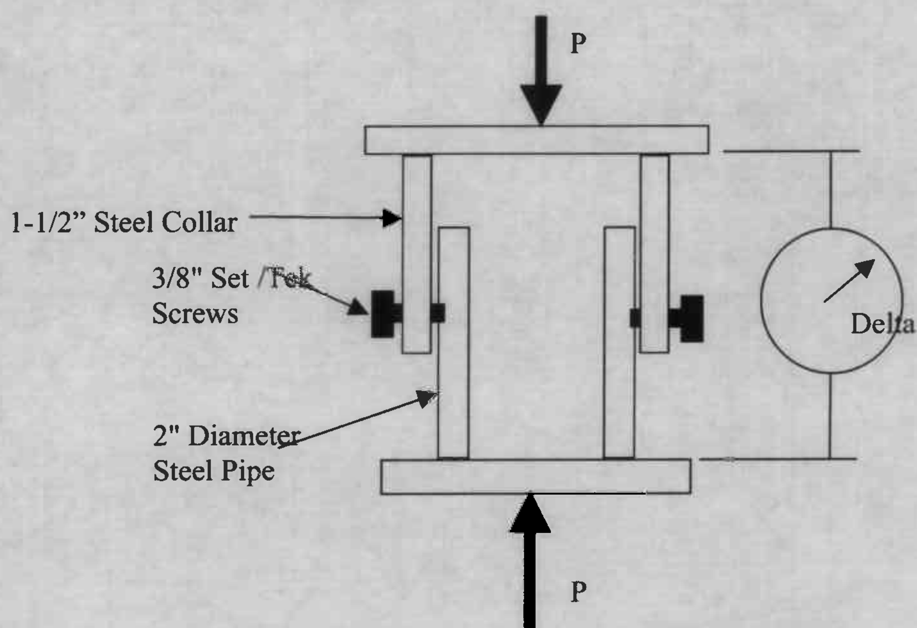
73

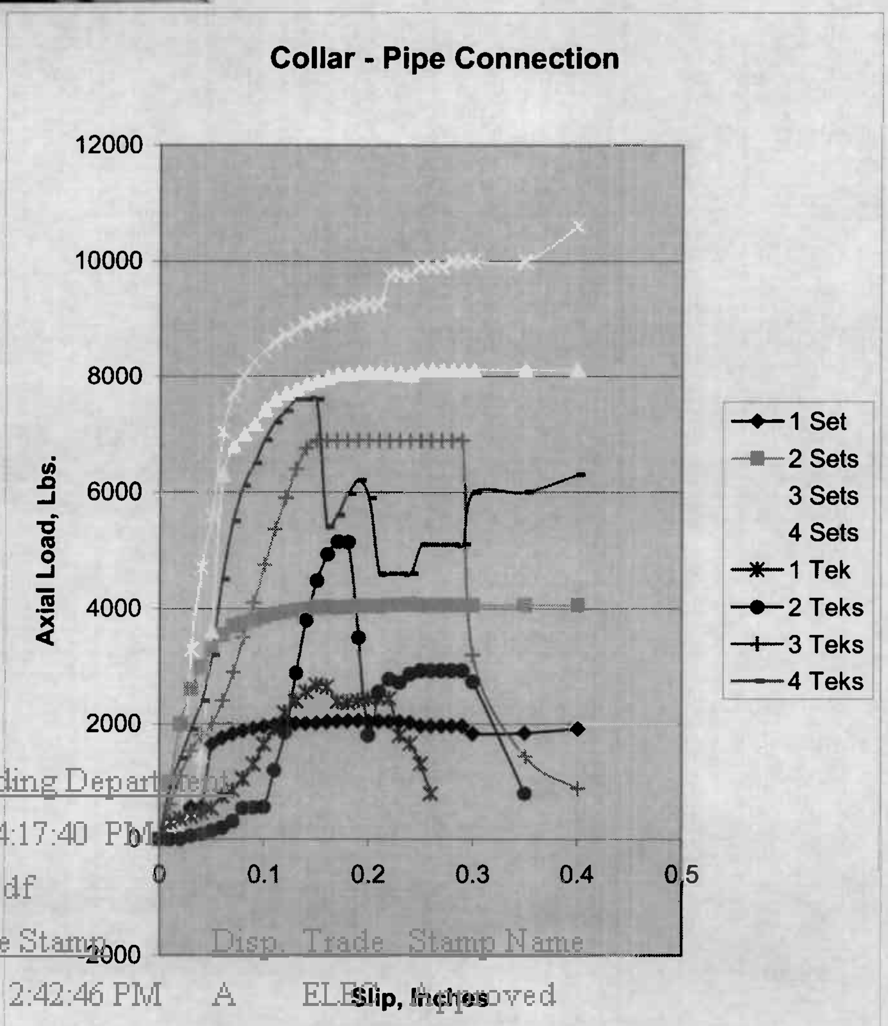
Load and Deformation of Steel Pipe Collars Connected with Set- and Tek-Screws

Varying numbers of 3/8" Set Screws (torqued to 35 ft-lb) and 3/8" Tek Screws were used to connect a 2-1/2" standard steel pipe collar to a 2" standard steel pipe. The assembly shown schematically belowe was tested in axial compression, as shown.

The high-strength steel set screws were torqued to 35 ft-lbs indented the 2" diameter pipe by approximately 1/32", and slid like butter through the softer pipe material as load was applied (see photo below). The set screws (aside from rotating slightly in the collar) were undamaged by the test. Using set screws, high energy absorption capability was demonstrated, as shown in the following graph of load versus displacement. The load carrying capability increased approximately in proportion to the number of set screws employed, as shown in the graph below.

The Tek-screws were not quite as strong as the set screws. Also, the Tek-screws sheared off, quite suddenly, one by one. See the photo below. The Tek-screws did not demonstrate as much energy-absorbing ductility as the Tek-screws. Like the set screws, the strength of the connection increased roughly in proportion to the number of Tek-screws employed in the connection.




Collar - Pipe Connection
Axial Load, Lbs.
Slip, Inches
12000
10000
8000
6000
4000
2000
0
-2000
0
0.1
0.2
0.3
0.4
0.5
1 Set
2 Sets
3 Sets
4 Sets
1 Tek
2 Teks
3 Teks
4 Teks

Permit #: Pending

Folio/Parcel Identification #: 33-5033-017-0170

Prepared By: SOLAR DIRECT

CFN 2012R0006121
OR Bk 27950 Pg 2713; (1pg)
RECORDED 01/04/2012 16:09:15
HARVEY RUVIN, CLERK OF COURT
MIAMI-DADE COUNTY, FLORIDA
LAST PAGE

NOTICE OF COMMENCEMENT

STATE OF FLORIDA
COUNTY OF Miami-Dade

THE UNDERSIGNED hereby gives notice that improvement(s) will be made to certain real property, and in accordance with Chapter 713, Florida Statutes, the following information is provided in this Notice of Commencement.

1. Description of property
   Street address: 8990 SW 177th Terrace, Miami, Fl. 33157
   Legal description:
   33 55 40 HERMAN HILLS 1ST ADDN PB 72-58 LOT 1 BLK 8 LOT SIZE 125.000 X 142 F/A/U 30-5033-017-0170 COC 24810-4930 08 2006 1
2. General description of improvement: Solar Energy System
3. Owner information
   Name: American Home Mortgage Servicing/Power REO - Rodel Catahan
   Address: 8990 SW 177 TERRACE, MIAMI FL 33157-0000
   Telephone: 866-612-3780
   Interest in Property: American Home Mortgage Servicing/Power REO
4. Fee Simple Title Holder (if other than owner shown above)
   Name and Address: n/a
   Telephone and Fax: n/a
5. Contractor
   Name and Address: Solar Direct, Inc 6935 15th St E, Sarasota, FL 34243
   Phone and Fax: (941) 359-8228; (941) 359-3848
6. Surety: n/a   Amount of Bond: n/a
7. Lender: n/a
8. Persons within the State of Florida designated by Owner upon whom notices or other documents may be served as provided by section 713.13(1)(a)7, Florida Statutes: None
9. In addition to himself, Owner designates the following to receive a copy of the Lienor's Notice as provided in section 713.13(1)(b), Florida Statutes n/a
10. NOC Expiration date (one year from the date of recording unless different date is specified):

WARNING TO OWNER: Any payments made by the owner after the expiration of the Notice of Commencement are considered improper payments under Chapter 713, Part I, Section 713.13 Florida Statues, and can result in your paying twice for improvements to your property. A Notice of Commencement must be recorded and posted on the job site before the first inspection. If you intend to obtain financing, consult with your lender or an attorney before commencing work or recording your Notice of Commencement.

[redacted] (Or Owner's Authorized Officer/Director/Partner/Manager   Kirk A Maust (Solar Direct)
Print Name

STATE OF FLORIDA, COUNTY OF Manatee

SWORN TO and subscribed before me this 10th day of November 20 11 by Kirk A Maust (Solar Direct) is [ ] personally known to me, or [ ] has produced driver's license as identification.

Donna Markham
Notary Signature

Donna Markham
Notary Printed Name

Commission Expiration Date:
NOTARY PUBLIC STATE OF FLORIDA
DONNA MARKHAM
MY COMMISSION # EE 035709
EXPIRES: October 19, 2014
Bonded Thru Budget Notary Services

Verification pursuant to Section 92.525, Florida Statues. Under penalties of perjury, I declare that I have read the foregoing and that the facts in it are true to the best of my knowledge and belief.

[redacted]ural Person signing above   Kirk A Maust (Solar Direct)
Print Name

Miami Dade County Building Department
0000714723 - 2/16/2012 4:17:40 PM
GENERAL01-01252012.pdf

Examiner	Date Time Stamp	Disp.	Trade	Comment / Name
Steven Gilbert	1/27/2012 2:42:46 PM	A	ELEC	Approved
Jeanne Clarke	2/16/2012 3:36:28 PM	I	STRU	Reference Only

STATE OF FLORIDA, COUNTY OF DADE
I HEREBY CERTIFY that this is a true copy of the original filed in this office on 04 day of JAN, AD 20 11
WITNESS my hand and Official Seal.
HARVEY RUVIN, CLERK, of Circuit and County Courts
By 4509 D.C.

CIRCUIT AND COUNTY COURTS CLERK IN GOD WE TRUST MIAMI-DADE COUNTY, FLORIDA